1-25-2021 11:00 AM

Ancient Egyptian Subadult Mummies: Unwrapping Childhood in the Ancient Past

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A thesis submitted in partial fulfillment of the requirements for the Master of Arts degree in Anthropology

ABSTRACT

This study documents the analysis of 21 subadult Ancient Egyptian mummies, spanning from the New Kingdom to the Roman Period, held on the Internet Mummy Picture Archiving and Communication Technology (IMPACT) database (Nelson & Wade, 2015), as well as a single first-hand osteobiographical analysis (Appendix A). The primary objective of this research is to determine if subadult Ancient Egyptian mummies were treated differently than their adult counterparts, paying specific attention to the potential for marked life history stages within subadulthood, as well as any temporal trends that may be observed. It was previously suggested that head positioning in the Graeco/Roman Period may be a point of differentiation between children and adults. Ultimately, in the absence of marked life history stages it became apparent that subadult treatment largely mirrored that of adults, with the exception of young female and Roman Period mummies, who revealed potential life history stage transitions during subadulthood.

KEY WORDS

Ancient Egypt, Subadult, Mummy, IMPACT, Computed Tomography, Osteobiography, Life History Stages, Childhood.

SUMMARY FOR LAY AUDIENCES

This study examines a sample of 21 Ancient Egyptian subadult (< 21 years of age) mummies, ranging from the New Kingdom to the Roman Period being housed in the Internet Mummy Picture Archiving and Communication Technology (IMPACT) database (Nelson & Wade, 2015). This represents 1,464 of the 3,755 years of Ancient Egyptian history, from the Early Dynastic Period to the end of the Roman Period (Shaw, 2003). This is the largest comprehensive comparative study done on Ancient Egyptian subadult mummies to date. The objective of this thesis is to establish whether Ancient Egyptian subadults were treated differently than contemporaneous adults in terms of their mortuary treatment. If then, they were treated differently, did these differences illustrate marked life history stages that may have been consistent with known temporal trends. In order to explore these questions, in addition to a comprehensive review of IMPACT, a first-hand case study will be presented, which involved compiling a sex and age-at-death estimate and osteobiography for a young mummy being stored at the Royal Ontario Museum.

This thesis delves into the realm of Ancient Egyptian subadulthood, which is largely unexplored, in order to better understand what life and death were like for children in this civilization. By analyzing a series of CT scans and X-rays, age and sex profiles were compiled for each of the sample individuals, allowing for the analysis of sex-based, age-based, and time dependent trends. It was concluded that unlike Western contemporary society, marked life history stages (e.g. Infancy, Adolescence), could not be detected in the mortuary treatment of these individuals, as subadults were largely treated the same as their adult counterparts. Two exceptions were observed: young female mummies, under the age of six years, who are largely absent from the archaeological record – perhaps due to a lack of perceived personhood, and Roman Period subadults who are observed with a head positioning unique to subadults of this period. These exceptions may illustrate the potential for marked life history transitions within subadulthood. This study illustrates the value of, and continued need for, further exploration into Ancient Egyptian subadulthood, as a great deal of history still needs to be 'unwrapped'.

ACKNOWLEDGEMENTS

I would like to extend my sincerest thanks to my supervisor, Dr. Andrew Nelson. From answering my countless questions to keeping me calm throughout the duration of this Degree, none of this would have been possible without his guidance, expertise, and patience. I would never have pursued my Master's Degree without having taken Dr. Nelson's Mummy Course in the third year of my Undergraduate education. Seeing someone who is so passionate about what they do, who is able to teach in such an engaging manner, about subject material that piqued my interest, led me to where I am today.

This project would not have been possible without the support of my advisor, Dr. Andrea Waters-Rist. It has always been an absolute pleasure learning from Dr. Waters-Rist, whether it was in the capacity of an Undergraduate student, a Teaching Assistant, or a Graduate student, her knowledge is seemingly endless. I would like to extend my gratitude to Andrea for her support, encouragement, and guidance throughout the writing process, as she was instrumental in the creation of this work.

Special thanks must be extended to Dr. Drew Smith for his time and countless contributions to the study of Nesmut. Dr. Smith's expertise in the field of dentistry and orthodontics was extremely significant and beneficial throughout the entirety of this thesis. Additionally, I would like to extend my gratitude to the individuals at The Royal Ontario Museum who made the analysis of Nesmut possible. Words cannot describe how grateful I am to have had the opportunity to study and learn from Nesmut. Specific acknowledgements for these individuals may be found following Nesmut's analysis in the Appendix of this work.

This thesis would not have been feasible without the funding provided by the Social Science and Humanities Research council, and so, my sincerest thanks is extended to them. I would also like to acknowledge the generosity of all of the individuals and institutions who contributed their X-rays or CT scans to the IMPACT database, particularly Ron Beckett, Jerry Conlogue, and the Yale Peabody Museum for their scans of the "Little Girl from Thebes".

To each of the individuals in the Faculty of Anthropology at The University of Western Ontario, I thank you. Specifically, I would like to extend my gratitude to the

following individuals for their assistance throughout the compilation of my thesis: Hope Atkinson, Lauren Poeta, and David Seston. To my colleagues who became my friends, and then my family, Kayla Golay Lausanne and Hilary Hager, thank you for putting up with me. Thank you for making me laugh when I could have very easily cried, and thank you for your continued love and support, both within and outside the realm of academia.

I would like to conclude my acknowledgements by thanking my friends and family. To my friends, specifically: Sarah McGrath, Brittany Dors, Ashley Edmondson, Isaiah Campsall, Samuel Campsall, and Joshua Bruinsma, thank you for always being my rocks. Thank you for grounding me when I was overwhelmed, and for always being 'my people'. To my parents, thank you for always pushing me to be my best and reminding me of what I was capable of when I doubted myself. Thank you for encouraging me to pursue my dreams, and for being the two people I can always turn to. Your unconditional love and support mean more to me than I could ever possibly convey. I love you both infinitely. Finally, to my partner, Jeffrey Bruinsma, your unwavering belief in me consistently reminds me to trust in myself. Your steadfast support throughout the writing process of this work has been instrumental and inspiring. You make me a better person each day, and for that, I will never be able to thank you enough. Everyday I am grateful that you chose me and continue to choose me. I am grateful for our family, our perfect little puppy, and I am forever grateful for you. I will always love you more.

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CHAPTER 1

INTRODUCTION

The marking of life history stages is an important aspect of the development of human cultural identity, yet only recently has the "bioarchaeology of childhood" sought to examine how these stages were defined in ancient societies (Kamp, 2001). In particular, surprisingly little is known about these important transitions in Ancient Egypt. This project examines a largely untouched collection of 21 subadult Ancient Egyptian mummies, all determined to be less than 21 years of age at death. This includes a first-hand macroscopic osteobiographical analysis (Appendix). This work presents the largest comprehensive comparative study of Ancient Egyptian subadult mummies to date, including 21 (Table 3.1) of the 96 subadult Ancient Egyptian mummies known to this author. The recorded subadults not explored within this work, due to an inaccessibility of radiological data sets, are listed in Appendix B.1. The goal is to better understand Ancient Egyptian subadulthood developmental milestones, both social and physical, and particularly the ways in which these milestones were reflected in their post-mortem treatment. The way in which personhood is defined and reflected in the mortuary treatment will also be considered throughout. For the purpose of this project, subadulthood is therefore etically defined as anyone under the age of 21 years, the age at which skeletal and dental maturation are mostly complete. Mummies have captivated learned and popular audiences around the world for centuries, and yet the academic literature surrounding subadult individuals is riddled with gaps, some of which this work seeks to fill.

1.1 PROJECT CONTEXT: SUBADULT ANCIENT EGYPTIAN MUMMIES

This project compares and contrasts the mortal record of these subadult mummies across temporal, developmental, and sex-based divisions by employing the world-wide database of radiological studies of Egyptian mummies, known as the Internet Mummy Picture Archiving and Communication Technology (IMPACT) database, which is housed at The University of Western Ontario (Nelson & Wade, 2015). Through the use of Computed Tomography (CT) and X-rays, which allow for the non-destructive examination of hard tissues, soft tissues, and associated mortuary cultural artifacts, this work presents the first broadly focused examination of possible socially constructed age

divisions between subadults and adults in Ancient Egypt based on mummification methods and mortuary practices.

In order to make the most informed comparisons possible, this work consults known standards surrounding Ancient Egyptian adult mummification within various temporal and geographical divisions (e.g. Loynes, 2015). It should be explicitly stated that theses comparisons will, at times, be oversimplifications, which may not be representative of the society as a whole. Unfortunately, however, these generalizations are necessary when one is examining known reference collections in order to establish divisions between adulthood and subadulthood in the mortuary record. Works including Loynes (2015), Bogin & Smith (1996), Wade & Nelson (2013) and Lacovara & Baines (2003) will be examined in order to establish these essential and valuable comparison points. As this work aims to present a holistic study, the limitations that accompany these generalizations are continuously acknowledged and considered throughout its compilation.

To date, the only systematic contributions to the study of subadult Ancient Egyptian mummies have come from one scholar: J. Davey. Although Davey has gathered a multitude of radiological studies of subadult mummies, she has not defined conclusive developmental phases, nor does she draw comparisons between the subjects beyond identifying that head position was different between child and adult mummies in Graeco-Roman times (Davey et al., 2008; Craig & Davey, 2009; Davey et al., 2014; Davey & Drummer, 2015).

Davey's work begins to consider the potential applications of comparative datasets within the field of mummy studies while also suggesting that subadults were treated differently than adults in Ancient Egypt. Furthermore, and perhaps similarly, Power (2011) has suggested that subadults were perceived differently than their adult counterparts, and that this was reflected in their mortuary treatment. She acknowledges that this research point remains incomplete as future studies should conduct "detailed biocultural analyses of children's (and adults') physical remains [as the] physical remains appear to hold the greatest potential to access reflections of their lived experiences throughout the life course" (Power, 2011:306). The differential treatment of subadults is also addressed by Janssen and Janssen (2007), who suggest that age grades may have

been differentiated by clothing and/or hairstyles in Ancient Egypt. An in depth analysis of each of these works will be provided throughout this work. The goal of this thesis is to build on and extend the findings of these previously published studies.

A final notable scholar, Meskell (2000), has previously proposed, on the basis of literary evidence, that life history stages in Ancient Egyptian culture may be initiated and completed by males and females at different chronological ages, with females generally maturing earlier. However, this concept has not been explored empirically and this subset of mummies presents the ideal microcosm in which to test her model. This thesis presents an objective, physical examination of subadult sex differences in life and in death, as they are reflected in literary references and preserved mortal remains. Additionally, the presence of soft tissue, a feature unique to mummies, allows for better estimations of the deceased's biological sex, something that is generally impossible in pre-adolescent individuals on the basis of osteological evidence alone (Morimoto, 1989; Davey et al., 2008).

In order to expand on Davey's work, and many others to a lesser degree, this project examines each of the 21 subadults currently in the IMPACT database using a critical and comparative lens. Particular emphasis is given to osteological observations that allow for the establishment of the individuals' age at death including epiphyseal fusion (McKern & Stewart, 1957; Buikstra & Ubelaker, 1994; Franklin, 2010) and dental formation/eruption (Moorrees, Fanning & Hunt, 1963; Ubelaker, 1987; Hass et al., 1994). This will allow for a better understanding of the main research questions within this thesis, which are listed below, and detailed further in section 1.3. The three primary research questions are:

1. Were subadult Ancient Egyptian mummies treated differently in death than their adult counterparts?
2. If subadult and adult Ancient Egyptian mummies are treated differently, do these differences reflect Bogin's life history stages (see section 2.1 below), as may be discerned by analyzing their postmortem treatment?
3. Does geographical and/or temporal variation exist in terms of the mummification of these subadults, and if so, are these trends consistent with those observed in adults of the same geographic and/or temporal division?

The answers to these research questions will shed important new light on the construction and development of social identity in Ancient Egypt.

1.2 RADIOLOGICAL IMAGING OF MUMMIES & IMPLICATIONS

The inherent value of CT scanning mummies becomes apparent when one considers that initially, before the development of computed tomography, the only method by which one could analyze a mummy was through unwrapping, X-rays and perhaps even an autopsy (Cockburn et al.,1975; Zenger, 2015). These procedures were almost certainly entirely destructive (with the exception of X-ray imaging), leaving little of the individual intact, if anything at all. Now, with the sophisticated CT technology that is available, researchers can "unwrap a mummy electronically without disturbing the body, wrappings or coffin – a kind of virtual dissection" (Hughes, 2011:59). It should not be surprising then, that the first CT scan of a mummy was conducted in 1977, just six years after it was used on a living person for the first time. The subject of the scan was the desiccated brain of a subadult Ancient Egyptian boy named Nakht. Nakht's ground-breaking scan was conducted by Derek Harwood-Nash and Peter Lewin in Toronto, Ontario and has proven to be a milestone in the imaging of mummified remains (Harwood-Nash, 1979).

Less than four decades after Nakht's initial scan mentioned above, IMPACT was developed. This database has allowed for the compilation of both X-ray images and CT scans, which thereby facilitates the repeated, non-invasive, and non-destructive analysis of each mummy studied throughout this project (Nelson & Wade, 2015). Each of these radiological data sets was then studied using ORS Visual^{Si} software, a functional processing tool available within IMPACT. This software allows for the compilation of both quantitative (e.g. bone metrics) and qualitative (e.g. burial positioning) observations whenever possible. It should also be noted that this type of analysis is both correlated to, and representative of, Western University's recognized research strength in Imaging Technology (Research Western, n.d.).

1.3 RESEARCH AIMS, QUESTIONS & PURPOSE

Life history stages are intrinsic to the development of one's individual, social, and cultural identity. However, the expression of the stages varies greatly from culture to culture. Very little is known about these divisions in most ancient cultures, with Ancient

Egypt being no exception. It should be noted that there are both emic and etic definitions surrounding the concept of life history stages. Emic definitions are those that define life history stages from inside the culture (Harris, 1976), in this case Ancient Egyptian culture. Etic definitions, on the other hand, are those that examine the definition of life history stages from outside of Ancient Egyptian culture (Harris, 1976). In order to explicitly frame the scope of this work, this project will employ a primarily emic approach to understanding life history stages insofar as the focus will be on the way in which these stages presented and were viewed by those within the Ancient Egyptian culture. This work seeks to further explore the concept that "funerary ritual and burial deposition often correlate with social persona and burials [as well as mortuary treatment, which] might be expected to reveal emic age categories" (Kamp, 2001: 6). This is not to say however, that this thesis will be entirely void of etic interpretations, as cross-cultural understandings of life history stages will also be referenced and compared throughout.

The primary objective of this research is therefore to examine whether distinct sequential stages can be detected within the treatment of Ancient Egyptian child mummies. This work employs a comparative lens as it aims to elucidate as much information as possible about the mortuary treatment of Ancient Egyptian subadults. These comparisons will be made between subadult individuals as well as adults who were mummified in similar geographic or temporal realms insofar as the evidence allows based on published descriptions.

A brief discussion of subadult treatment across different geographical and temporal divisions outside of Ancient Egypt will also be included in order to provide a comprehensive collection of comparison points. These case studies, despite their brevity, will establish that differential treatment of subadults, in comparison to adults, has been established within a multitude of ancient populations. For example, in Roman Britain many animal and infant remains were buried beneath malting floors. These burials were kept entirely separate from those of adults and older subadults, which the author proposed might be due to the fact that infants in this society were viewed as less valuable from a social perspective (Scott, 1991). This particular example demonstrates that there was unique mortuary treatment based on perceived life history stages within this population. Similar studies will be further explored later in this work.

Additional secondary research questions and themes are present throughout this work, which tend to focus on the verification of, or lack thereof, sex differences seen throughout the dataset. This work seeks to explore Meskell's (2000) theory that males and females in Ancient Egypt progressed through age divisions at different rates, to better understand if this is a trend that is visible in the mortuary record. Finally, with reference to the case study of Nesmut (Appendix), as a subadult (between the ages of six and eight years), holding the title of 'Lady of the House, Chantress of Amun-Re' at the time of her death, this work explores how she may have achieved such a high title, which was previously, and perhaps inaccurately, assumed to be held exclusively by adults.

These inquiries are innately pertinent to the field of anthropology, as Ancient Egypt lies near the base of the tree of the development of complex cultures and civilizations. Ancient Egyptian society presents a unique window into the past, one that offers tangible evidence of human behaviour, whether through the monumental architecture of the pyramids, documented papyrus scrolls, or the mummified remains of the actual Ancient Egyptians (Kemp, 2015). Furthermore, Ancient Egyptian subadults, or perhaps more specifically, their mummified remains, represent a largely unexplored and data rich study population. Childhood, as a construct, is innately fascinating as it has the ability to elucidate the cultural beliefs, societal pressures, and life history stages that existed within each population in life, and perhaps also in death. With the implementation of a holistic framework, this project aims to establish the foundation upon which future research and comparative studies may be conducted.

1.4 ETHICAL CONSIDERATIONS

When researchers work with humans there is a set of ethical requirements that must be recognized and honoured, whether the individuals are living or deceased (World Archaeological Congress: Vermillion Accord, 1989). Certainly, one of these expectations when working with mummified individuals is to ensure that the research is as minimally invasive as possible. For this reason, this project aims to be entirely non-invasive, as it will involve the analysis of CT scans, rather than the sampling of physical bony material. Furthermore, this work is directly correlated to the concept of personhood, which is then inextricably interconnected with the goal of any successful osteobiography: to reconstruct the identity of the deceased. Reconstructing the life history of an

individual, particularly a subadult, is a task that requires a great deal of respect for the deceased and their identity, which is held at the utmost importance throughout this work (e.g. Lonfat, Kaufmann & Rühli, 2015).

When conducted properly, "mummy research – within a framework of ethical constraints and guidelines – shall be just as sustainable, and thus of long-term benefit to modern science as any kind of research on human remains and human tissue is in modern society today" (Lonfat, Kaufmann & Rühli, 2015:1180). Furthermore, emphasis will be placed on the fact that people, whether alive or deceased, "deserve protection from destruction for the same reasons that apply to objects in museums: they are unique and irreplaceable" (Clavir, 2002:55). An informed and sound ethical framework will be instrumental to the research being proposed in this work as respect for, and recognition of, personhood is of paramount importance in the analysis of subadult human remains.

1.5 CHAPTER OUTLINE

In order to provide the reader with a brief overview of the content included within this work, please see the chapter outline presented below:

Chapter 1 – Introduction: This chapter presented the context and framework within which the project was conducted. A short overview of radiological imaging, in terms of its applications, implications, and ethical concerns within mummy studies, as well as an explicit overview of the research aims, questions and purpose was included.

Chapter 2 – Life History Stages and Subadults in Ancient Egypt: This chapter explores the existing literature surrounding subadulthood in Ancient Egypt. This chapter examines modern life history stages as well as the modern application of osteobiographical studies, including the work of J. Davey. Additional topics presented within this chapter include: the relationship between personhood and subadults as well as documented subadult death both within the Ancient Egyptian culture as well as elsewhere. Further exploration of the relationship between artistic depictions of subadults and coming of age rituals in Ancient Egypt will be examined.

Chapter 3 – Methods & Materials: Review and Applications: This chapter focuses on the materials and methods that were employed throughout this thesis. This chapter begins with a detailed review of applicable methodological practices, which includes both subadult sex and age estimation methods. Then it provides an overview of the history of

CT imaging both generally, and in terms of its archaeological applications. Additionally, a detailed account of the materials and methods employed throughout this work, including the checklist developed for this project is provided. An overview of the IMPACT database, its processing software, and the focal sample population held within said database is then presented. Finally, this chapter concludes with a walkthrough of the procedures used in data procurement.

Chapter 4 – Results: This chapter provides the data output of the study in the absence of interpretation. These results include the findings of the following diagnostic aging estimation techniques, mummification characteristics, and any additional observations.

Chapter 5 – Discussion: This chapter explores the results and interprets them in order to establish patterns, trends, and informed potential conclusions. This section systematically reviews each of the subcategories listed within Chapter 4 in order to present, compare, and contrast all relevant findings and establish their broader applications.

Chapter 6 – Conclusion: This chapter presents the overall findings of this work by revisiting the research aims and purpose, while also exploring a multitude of future research opportunities.

Appendix – Nesmut: A First Hand Osteobiographical Case Study presents the examination of an Ancient Egyptian subadult mummy housed at the Royal Ontario Museum, formally known as Nesmut (ROM 910.268.1), whose coffin identified her as a Chantress. This case study presents all available background information on this subadult individual, the materials and methods used throughout the analysis of her remains, the results of her workup, a discussion of the results, and finally a comprehensive conclusion of this first hand osteobiographical analysis.

CHAPTER 2

LIFE HISTORY STAGES & SUBADULTS IN ANCIENT EGYPT

In the words of Samuel Smiles (1881, n.p.), "childhood is like a mirror, which reflects in the afterlife, the images first presented to it. The first thing continues forever with the child. The first joy, the first sorrow, the first success, the first failure, the first achievement, [and] the first misadventure, paint the foreground of his life". Certainly, subadulthood is a period of firsts, whether one is considering this statement through a sociological or physiological lens, it remains equally poignant and valid. Oddly enough however, despite the fact that every adult individual has experienced subadulthood, it would seem as though there is no single, entirely agreed upon, definition for this stage of one's life history. The ambiguity surrounding the concept of childhood is by no means a product of modern society or thought, but rather, this life stage has remained difficult to define throughout much, if not all, of antiquity.

Additionally, modern society recognizes the progression of individuals through marked age divisions such as baptisms, bar mitzvahs, age of majority and so on. However, projecting these contemporary constructs onto Ancient Egyptian culture is problematic. It is the act of applying current societal theories to ancient communities that creates "such a premodern/modern dichotomy, permeated with ethnocentric claims, [which] fails to accord with Egyptian evidence of the lifecycle" (Meskell, 2002:89). This sentiment is solidified when one observes the method in which contemporary people "have attributed to [their] own culture an emotional complexity and depth of feeling that is somehow distinctive, whereas the ancient data challenges[s] [their] temporal chauvinism" (Meskell, 2002:89).

This thesis will examine the theoretical aspects of life history stages, paying particular attention to the bioarchaeology of childhood within Ancient Egyptian society, as reflected in the mortuary program. In order to conduct a critical and holistic examination of the existing literature, the analysis presented here will be divided into two overarching categories between Chapters Two and Three of this thesis, the first of which focuses on the underlying literary evidence surrounding Ancient Egyptian subadulthood. Chapter Three then examines the methods by which observable elements of subadulthood may be detected, as reflected in the archaeological record.

2.1 EXISTING LIFE HISTORY STAGE STANDARDS

Societies at large tend to classify individuals into particular life history stages based on their chronological age and/or their social achievements. Terms such as 'Childhood', 'Adolescence', and 'Adulthood' are commonly used to indicate the age of an individual, as reflected in their biological and physiological markers (e.g. Bogin & Smith, 1996:703). However, these terms are largely human constructions. Although these divisions may have been generally accepted and integrated into both modern and ancient societies, they are certainly problematic if blindly applied in all cases. For instance, to define children as individuals under the age of 12 years, is an oversimplified definition given the variability that exists and is observable in youth. At the age of 12 some individuals have undergone puberty, whereas some will not experience this for another five years. There are individuals who are articulate, motivated, compassionate and critical at the age of 12, whereas there are others who are immature, irresponsible, and naïve. The overarching message here is that to ascribe a static, finite, and rigid classification system to a group of fluid and dynamic people, is complicated to say the least. Although there is nothing inherently wrong with applying life stage definitions at any chronological age, it must be noted that the boundaries of any given division are certainly not absolute, with the exception of death.

To provide an example of a well-recognized age classification system, Barry Bogin (2012), one of the most notable scholars who studies life history stages, has etically defined six unique age divisions. These stages include the following, in chronological order: "Infancy", "Childhood", "Juvenile", "Adolescence", "Adulthood", and the "Late Life Stage" (Bogin, 2012). Although Bogin's stages primarily focus on somatic growth indicators, he does include social factors within the diagnostic criteria for each life stage. It should also be stated that from this point forward, when one of these stages is being referred to within this work, the division will be capitalized (e.g. 'Childhood'). In the absence of such capitalization, the use of the term 'childhood' is meant to be synonymous with the term 'subadult', again meaning any individual less than 21 years of age. Given the scope of this project, only the first four of Bogin's stages will be explored in depth, as these terms will be used throughout this work according to the definitions Bogin prescribes, which will be detailed below.

First, Infancy is said to occur from the "second month to the end of lactation, usually by 36 months" and is characterized by "deciduous tooth eruption [and], many developmental milestones in physiology, behaviour and cognition" (Bogin, 2012:293). Following Infancy is the Childhood stage, which occurs between ages three and seven, at which time there is a "moderate growth rate... [and a reliance] on older people for care and feeding" (Bogin, 2012:293). This stage also includes a few diagnostic markers, which include the "mid-growth spurt, eruption of the first permanent molar and incisor [and] cessation of brain growth by [the] end of [this] stage" (Bogin, 2012:293).

After Childhood, one is then said to enter into the Juvenile stage. The age at the time of this progression, according to Bogin (2012), is sex dependent. The Juvenile stage occurs between the ages of seven and ten years for females, whereas males may remain within this stage from age seven until twelve (Bogin, 2012). Within the Juvenile stage the individuals experience a "slower growth rate, [they are] capable of self-feeding, [and they experience a] cognitive transition leading to learning of economic and social skills" (Bogin, 2012:293). Finally, Adolescence, the longest of the stages mentioned above, lasts for five to ten years and begins after puberty (Bogin, 2012). This stage is characterized by a "growth spurt in height and weight, permanent tooth eruption [being] almost complete, development of secondary sexual characteristics, sociosexual maturation and intensification of interest in and practice of adult social, economic and sexual activities" (Bogin, 2012:293).

Given the importance of puberty to the latter etically defined stages, it should be noted that Bogin considers puberty to occur at the "end of the juvenile stage and [it] is an event of short duration [when compared to any of the physical life stages]... [Puberty then involves the] reactivation of [the] central nervous system of sexual development [along with a] dramatic increase in [the] secretion of sex hormones" (Bogin, 2012:293). Throughout this project reference will be made to these life history stages in order to establish how they may apply to the Ancient Egyptian study population, as it has been observed that these stages often map appropriately onto many non-western societies (Bogin, 2012). That is not to say that these stages are to be blindly and uncritically applied to ancient populations, however the applicability of these marked stages should also be considered. Evidently, the cognitive milestones Bogin addresses will not be

quantifiable within the scope of this work, however any diagnostic physiological markers that may be detected will be examined with reference to these stages.

2.2 LIFE HISTORY STAGES – A CROSS CULTURAL PERSPECTIVE

As mentioned above, Bogin's (2012) assessment of life history stages appears to translate remarkably well across many cultures, given the time at which rites of passage occur within these societies (Van Gennep, 1960). Perhaps this is because of the likeness seen across rites of passage as there is a "wide degree of general similarity among ceremonies of birth, childhood, social puberty, betrothal, marriage, pregnancy, fatherhood, initiation into religious societies, and funerals" (Van Gennep, 1960:3). Although these are social rites of passage, rather than physiological changes in the body itself, they continue to emphasize the separation between subadults and adults, as well as the progression from the latter to the former.

Additionally, many of these social rites of passage coincide with the physiological changes that Bogin (2012) uses as a marker of his life history stages. To provide some clarification, consider the following examples, which attempt to elucidate that life history stages are observable across multiple cultures at similar chronological ages. First, in Hindu culture "childhood lasts until the performance of the important ceremony (at eight, ten or twelve years) called 'entering school'; this marks the beginning of adolescence" (Van Gennep, 1960:55). Although this particular example does not explicitly mention the transition from the Childhood stage to the Juvenile stage, it does highlight the progression from Childhood to Adolescence, much like Bogin (2012). Notably, both this Hindu practice and Bogin's life history stages suggest that Childhood ends around the age of seven or eight years as they begin school (Van Gennep, 1960:55), and undergo a "cognitive transition leading to the learning of economic and social skills" (Bogin, 2012:293).

As a second cross-cultural example, consider that the Minhow, a recent Chinese sect, recognize a ceremony explicitly called the "departure from childhood" (Van Gennep, 1960:57). This ceremonial rite occurs at the age of sixteen when the subadults are no longer considered to be under the protection of the 'Mother' deity (Van Gennep, 1960). Although this social transition from Childhood to Adulthood does not involve the identification of a Juvenile or Adolescent stage it does further support the existence of

life history stages. It is also notable that this transition into Adulthood in Minhow culture corresponds to Bogin's Adolescent stage, at which point the individuals are said to experience an "intensification of interest in and practice of adult...activities" (Bogin, 2012:293).

Although the precise terminology may differ between cultures, given the above examples, it is evident that various life history stages are recognized cross-culturally (see Van Gennep, 1960 for additional examples). Furthermore, as highlighted in the above examples, these stages often correspond well with the divisions coined by Bogin (2012), further solidifying the importance of his work and the applicability of it to this project. Finally, a separate trend that appears salient cross-culturally surrounds the existence of and establishment of personhood as it corresponds to both social and physical maturation. This concept, and a definition for the term 'personhood' will be explored within the following subsection of this chapter. Notably however, this transitional period into personhood does not appear to have the same correlation to the life history stages defined by Bogin (2012). The above examples show that life history stages can be marked by changes in mortuary practice, however this does not lead to the conclusion that all cultures illustrate such a clear correlation.

2.3 PERSONHOOD & LIFE HISTORY STAGES

In order to elaborate on the interconnectedness, or lack thereof, between *personhood* and life history stages it is imperative that a definition of personhood is explicitly provided. In this thesis, personhood is defined as the social recognition of an individual as a complete, living entity. This becomes increasingly interesting as one considers what exactly makes an individual 'complete' and how this differs cross-culturally. An examination of personhood in Ancient Egypt will be presented later in this chapter, however this subsection focuses on the idea of personhood across multiple cultures and the way in which it is related to life history stages.

The first example of achieving personhood offered here is the Ainu people of Japan, who believe that "only on the twelfth day is the child a complete and autonomous individual" (Van Gennep, 1960:53). The explanation for this belief appears to stem from the principle that "it takes several days of real life for the child to become an individual" (Van Gennep, 1960:53). This suggests that in order to achieve personhood in the Ainu

society the child must survive to the twelfth day of life, at which point they are recognized as complete persons. Notably, this very specific interval of twelve days does not correspond directly to any of Bogin's (2012) life history stages. However, a short, critical period just after birth (perinatal/neonatal) certainly reflects similarities, which appear salient across cultures. The twelfth day, according to Bogin (2012), falls into the Neonatal Period, which occurs between birth and 28 days of age.

As a more general example, many cultures rely on the act of naming in order to allow the subadult to be recognized as a complete entity, or person (Van Gennep, 1960). This is because it is believed that "when a child is named, he is both individualized and incorporated into society" (Van Gennep, 1960:62). Although naming may occur at any stage of an individual's life, it generally tends to occur soon after birth, making this transition into personhood difficult to correlate with Bogin's (2012) life history stages. With that in mind, it should be stated that in some cultures the subadult may "change names as often as he changes age categories into childhood" (Van Gennep, 1960:62). This illustrates that cross-cultural recognition of life history stages in relation to personhood do exist. However, the concept of personhood is perhaps less correlated to Bogin's standards than the rites of passage mentioned in the previous subsection. Although it should be noted that Bogin does not examine the concept of personhood directly in his publications, it appears as though he believes that personhood begins only after birth, as his life history stages do not include embryonic or fetal development. Further analysis of personhood will be provided in terms of application to Ancient Egypt later in this chapter. The following subsection will however, step away from this concept in order to examine contemporary views and advancements surrounding the presence of life stages and how this work will seek to fill the gaps that remain.

2.4 MODERN LIFE STAGES – ANALYTICAL CONTEXT

Recently, there have been a multitude of advancements in the field of subadult osteology (e.g. Boccone et al., 2010). However there has not yet been a comprehensive analysis of the applicability of life stage divisions to subadults in the mortuary record. Throughout much of the academic literature surrounding the examination of subadult remains, "many terms are employed to describe individuals who are not yet considered mature. In fact, there is no agreement on exactly when an individual becomes [an] adult"

(Baker, Dupras & Tocheri, 2005:3). Although evidently Bogin (2012) presents a compelling set of life stage divisions, they have not been accepted or adopted as a general cultural standard, contributing to the ambiguity surrounding these terms. Additionally, there continues to be a dichotomy presented between that of chronological and social age in some societies and situations. This sentiment is echoed by Lewis (2007), as she states that "one of the resounding issues with the definition of a 'child' in archaeological contexts is the use of physiological age to determine a social category" (Lewis, 2007:5).

Furthermore, according to Baker, Dupras & Tocheri (2005), every individual who has not yet completed their physical growth can be classified under the umbrella category of 'subadult'. Additionally, "the age at which an individual leaves the world of dependency, learning to play, and takes on roles of work and social responsibility is neither distinct nor universal" (Lewis, 2007:5). What can be somewhat standardized however, is the biological age of the individual, which can be examined through the "development of teeth, length of the long bones, and union of the epiphyses" (Ubelaker, 1999:63). Generally, once an age estimate has been made for the deceased, the individual is sorted by the bioarchaeologist into an age category, which although these categorizations remain imperfect, they should be presented and defined, as they are still commonly seen in the academic literature, often forming the basis for cross cultural comparisons (e.g. Bogin, 2012). The power of bioarchaeology becomes evident when one considers that "bioarchaeological information can elucidate the lives of children and the meaning of childhood in antiquity. Bioanthropological techniques additionally can identify biological developmental stages of childhood that may link to socially defined age grades" (Perry & Webb, 2006:89).

2.5 OSTEOBIOGRAPHY

The word 'osteobiography' was coined by Frank Saul in 1961 and has been used in countless publications since (e.g. Saul & Saul, 1989). Taking a literal approach, the term "osteo" means "bone", while the word "biography" is an account of an individual's life, which was composed by another person (Saul & Saul, 1989). The term in totality then may be defined as: the reconstruction of the deceased's life as told by their physical bony, and in some cases soft tissue, remains. In addition to the human remains of the individual, in order to create a comprehensive profile of the deceased, when available,

associated grave goods and context may also be analyzed as indicators of sex, age, status, and ancestry. Although osteobiographies are essential tools in the reconstruction of individuals' life histories, there are confounding variables that should be adequately considered during such analyses.

Reconstructing the identity of a person who lived thousands of years ago is certainly not an easy task, however it is an important undertaking. When creating an osteobiography, often the first characteristics researchers will attempt to establish are the deceased's sex and age at death (Krishan et al., 2016). Although there are instances in which it may not be possible to make these determinations, they remain pertinent in both forensic and archaeological contexts as they begin to establish the identity of the deceased. Throughout this report various methods of sex and age estimation will be detailed, reviewed, and critically engaged with in order to establish which techniques appear to be the most diagnostic and reliable. Once these aspects of identity have been reconstructed to the best of this project's ability, comparisons will be made both within the study population and beyond it in order to truly explore the differential treatment of subadults within Ancient Egypt. It should also be noted that osteobiographies generally attempt to establish paleopathology, ethnicity, migration patterns, and reconstruct paleodiet whenever possible (Saul & Saul, 1989; Krishan et al., 2016).

2.6 ARCHAEOLOGICAL EXAMPLES OF MORTUARY TREATMENT OF SUBADULTS ELSEWHERE

Many studies worldwide, which include a multitude of temporal and geographical divisions, present evidence of differential treatment of subadults in comparison to adults (e.g. Scott, 1991). The existing literature was explored in reference to the mortuary treatment of subadults in Ancient Greece and Ancient Rome for comparative purposes. Unfortunately there is a great deal of conflicting evidence within the written record of both of these societies and a concise synthesis would constitute a thesis in and of itself.

Three unique case studies of differential mortuary treatment will be presented in this section. The first example of differential mortuary treatment of subadults refers to Bronze Age Ireland. At this site the remains suggest that subadults were not provided with full burials, meaning ceremonial rites and physical burial, until the age of approximately 14 years (O'Donnabhain & Brindley, 1990). This would then appear to

present an emically determined life history marker, at which the division occurs around the 14th year of life, which etically speaking correlates to a late commencement of Adolescence (cf. Bogin, 2012). This example was chosen simply to illustrate that examples of division between subadults and adults within the mortuary record exist, and it will also provide a point of comparison geographically and temporally for the subsequent examples. Furthermore, this time period was contemporaneous with the early end of the Egyptian sequence that this work examines.

Consider that although the temporal period and geographical region remains the same as the previous example, in Bronze Age Scotland, subadult remains were treated differently than they were in Ireland (Scott, 1991). In this case study, subadult burials were highly uncommon unless they were found within the existing burial of an adult individual (Small, Bruce & Shepherd, 1988). This is in contrast to those of Bronze Age Ireland in which the remains of subadults were not typically found with other individuals. It is possible that this may be the result of subadults being viewed as not fully formed people, having not achieved personhood and therefore being unworthy of their own burial space, leading them to be included within the burials of adults. It should be noted however, that a multitude of other equally valid conjectures may be presented to explain this mortuary treatment. This example was chosen because it exhibits that there were temporal differences seen in burial practices, while also touching upon the concept of personhood, which was addressed earlier in this chapter.

Finally and contrastingly, the third case study stems from Neolithic Italy. Within this population subadult burials were found almost exclusively in caves, whereas the remains of adults were commonly found within settlement areas (Skeates, 1991). A similar conclusion may be drawn from this finding, which may suggest that subadults were not entirely complete people and were therefore not buried within socially bounded locations, but rather were removed from the living social, or complete, realm. This example illustrates that there were geographic trend that may be observed in the way in which subadults were treated post-mortem.

These case studies are intended to illustrate that subadults have been treated differently than adults in the mortuary record across temporal and geographical divisions based on their age at death. There are many plausible reasons for this differential

treatment. The purpose of these three case studies is to illustrate that although the general concepts of personhood and subadulthood are often salient across cultures, the details surrounding burials and mortuary treatment often differ. These three case studies emphasize the fact that although there are small differences in the details surrounding how subadults were treated across geographical and temporal regions, what is consistent is that subadults and adults were treated differently posthumously. Despite the fact that differential treatment has not been studied comprehensively within Ancient Egypt, some findings have been published, which support the possibility of differential mortuary treatment based on age. These findings will be presented and examined in the subsequent subsection of this chapter.

2.7 DAVEY'S EXISTING RESEARCH ON SUBADULTS IN ANCIENT EGYPT

Dr. Janet Davey of Monash University has conducted what appears to be the only published series of analyses of multiple subadult Egyptian mummies from two time periods. Although her findings are largely presented as case studies, rather than comparative examinations, her conclusions are important. Prior to delving into these case studies, Davey notes that "there are some variations [surrounding] standard[s] in individual mummies and this may suggest regional differences in mummification practices or changes due to Hellenistic or Roman influences" (Craig & Davey, 2009:15). Given this statement, it appears as though the author believes that temporal and social differences were present and influential in subadult mummification practices. This hypothesis will be explored further throughout this work, as it appears that there are various opinions surrounding this concept.

Davey's studies unveiled a considerable amount of variation seen amongst Graeco/Roman Period subadult mummies in general, with perhaps only one characteristic remaining uniform across each of the fourteen accessible specimens. Evisceration, the removal of the internal organs, did not appear to be consistent throughout the Graeco/Roman Period, as in some individuals "no organs are visible within the thorax or abdomen" (Craig & Davey, 2009:18), whereas in others "inspection of the lower torso...failed to identify an embalming incision" (Davey et al., 2014:84). It should also be noted here that the evisceration incision may have occurred at locations other than the lower torso. The same can be said for excerebration, the removal of the brain, as it was

inconsistent across time periods, and sex and age groups. It appears as though evisceration and excerebration happened more often than not in Graeco/Roman subadult mummification rituals, however additional research will be required to determine the strength of this trend (Davey, Taylor & Drummer, 2014:208).

Body placement is inherently difficult to study in mummified individuals, as the process of mummification brings with it accompanying complications, such as shifting of the body and post-mortem alterations (Brothwell, 1987). Although in principle, body positioning could be used as a diagnostic determinant of patterns in mummification, it would be complicated by postmortem movement and fragmentation. Despite these apparent confounding variables, Davey has suggested that there "may have been a previously-unreported regional preference for positioning the body according to sex [in subadult mummies]" (Davey et al., 2014:84). This proposed correlation was a result of the analysis of three subadult Graeco/Roman Period mummies, two of which were female, while the other was male. Davey observed that the "females [had] the left hand under the left thigh, the left foot slightly over the right foot and the right hand resting beside the right thigh, while the male [was] positioned in the opposite way" (Davey et al., 2014:84). Caution is advised when suggesting that these limited findings constitute broad patterns, particularly when sex estimation in subadult remains is inherently difficult, not to mention the potential shifting of the body that was mentioned above. Perhaps it is these confounding variables that led Davey to state that in order to verify these conclusions a great number of additional studies would need to be conducted.

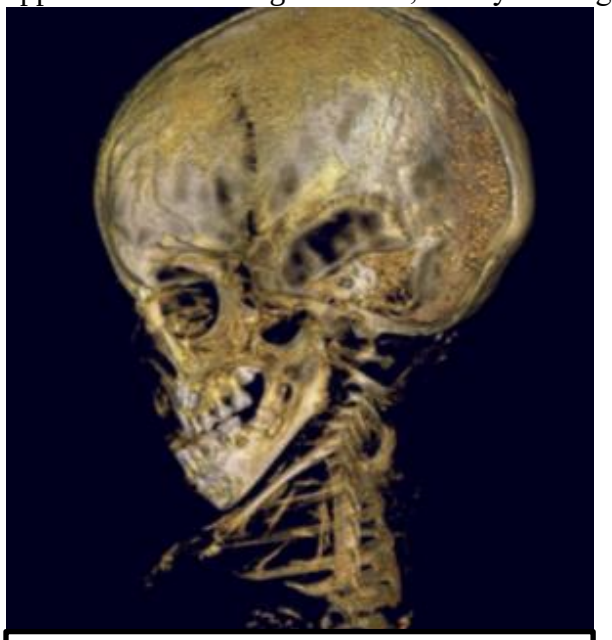

Figure 2.1 – 3D reconstruction of a Graeco-Roman subadult illustrating Davey's 'head-down' position, showing cervical vertebra damage. (Davey, J., Taylor, J.T. & Drummer, O.H. (2014)).

One trait that does remain salient and consistent across each of the fourteen subadult Graeco/Roman individuals Davey examined, regardless of age or sex, is the

placement of the head and mandible. The heads of subadult mummies were forced in a downward position toward the sternum of the individuals in such a forceful and deliberate manner that oftentimes the cervical vertebrae were displaced or fractured (Figure 2.1). The author documents this phenomenon in all of the male, female and indeterminately sexed subadult mummies she examined, who ranged in age from approximately 1.5 – 7 years, placing them within Bogin's (2012) Infancy or Childhood stages. Davey explains that this 'head-down' position, as she calls it, is seen in "all Graeco/Roman child mummies that have been studied by the authors to date. The reason for this is unknown and appears to be particular to the Graeco/Roman Period" (Craig & Davey, 2009:20).

Davey's work is, of course, inherently valuable both within and beyond the realm of mummy studies. However, her research could be far more valuable with further exploration of her findings both beyond, and within, the Graeco/Roman Period. Further examination of the age of initiation and termination of the head-down position in subadult mummies may prove to be beneficial to the demarcation of life history stages as well as historic time periods. This remarkable pose was clearly a purposeful component of mummification as "in each case the hyper-flexion of the cervical spine and the chin forced towards the sternum suggested that extreme force was used to manipulate the bodies into this unnatural position" (Davey, Craig & Drummer, 2014:25). Since this positioning was apparently unique to subadults, and did not extend to Graeco/Roman adult burials, if one was able to determine the youngest and eldest instances of this positioning, the life stage parameters may be better defined within the context of the Graeco/Roman Period.

Furthermore, the establishment of a quantitative age range, even within one temporal period, would likely prove to be beneficial in understanding the divisions between Infancy, Childhood, Juvenile and Adolescent life stages, as seen through the eyes of Ancient Egyptians, particularly in terms of those from the Graeco/Roman period. If this remains impossible, the research should illustrate the existence of life history stage transitions, upon which the stages may potentially be better understood. Davey's work, although case study based, is a step in the right direction, as it begins to consider the potential applications of comparative datasets within the field of mummy studies. With

consideration for both the theoretical and tangible components of Ancient Egyptian subadult mummification, as detailed throughout this literature review, a strong foundation can be formed upon which to build future research.

2.8 THEORETICAL LIFE STAGES TO QUANTITATIVE ANALYSIS

Defining subadulthood in Ancient Egypt has proven to be a complex and intricate task. This is, in large part, a reflection of the inaccuracies presented in assuming uniformity across time periods and/or amongst any given population of individuals, particularly those of the ancient past. Differences exist both within and across sexes, ages, time periods, and in the most basic sense, individuals. Furthermore, it is must be stressed that there is "no conclusive textual evidence as to how subadults were perceived by various groups, if they existed within a liminal zone or were considered incomplete individuals until a certain age" (Meskell, 1999:130). This is not to discredit the examination of clothing, hairstyles, or coming of age rituals, which will be presented later in this chapter. However, it is meant to reinforce the fact that the trends or patterns addressed are perhaps not entirely cohesive or conclusive.

Furthermore, the academic literature remains riddled with gaps surrounding what subadulthood was in Ancient Egypt, how it unfolded, and exactly how it could be differentiated from adulthood. Despite the holes in this literary framework, there are a multitude of quantitative analyses that can now be employed to estimate the age at death of an individual within a reasonable degree of scientific certainty. With a necessary eye for ethical considerations, these approaches and technologies will be detailed, and subsequently applied to a sample of subadult Ancient Egyptian mummies. This analysis will aim to further explore the biological determinants of subadulthood, while also considering the social realm, specifically personhood, insofar as it may be studied within subadults' mortuary programs.

2.9 PERSONHOOD IN ANCIENT EGYPT

One of the most important questions to consider when one is examining personhood is where exactly the recognition of this concept begins. There is an ongoing debate in modern Western society regarding when 'life' truly starts, as some consider the moment of conception to be the initiation of life (Ford, 2002), whereas others believe it is not until birth that one comes to be 'alive', or to be a complete 'person' (Ford, 2002).

Although this thesis does not focus on the twenty first century debate surrounding the initiation of life, it is important to establish what exactly one means when one employs the term 'alive', due to its direct correlation with the commencement of Childhood. Life can be examined from a multitude of different angles, including but not limited to: biological life, spiritual life, and social life. The interplay between these types of existence becomes apparent when one considers that oftentimes, as was the case in Ancient Egypt, spiritual and social life can transcend the traditional understanding of biological, or clinical, life (Figure 2.2).

It has been determined that in Ancient Egypt "while already in the womb, the unborn child was considered a living being and as such required protection from the social realm" (Meskell, 2000:425). This would suggest that for Ancient Egyptians, life begins in utero, prior to physical birth. However, additional literature indicates that although fetuses were considered to be alive, they may not have been deemed 'persons' until after birth, meaning personhood had not yet been achieved (Meskell, 1999). Note that mummified Ancient Egyptian fetuses will be discussed in detail in the later chapters of this thesis, however, it should be noted that they are extremely rare (Nelson et al., 2018). The academic literature consistently reports that Ancient Egyptian subadults received their names "at birth, since without a name the individual could not exist" (Hornung, 1992:178). Meskell then notes that "since it has been suggested that individuals were named at birth, it could be inferred that they were regarded as individuals with tangible trajectories within life and death" (Meskell, 1999:173). The importance of a name and its supposed intrinsic relationship

Figure 2.2 – The birthing process as depicted in Ancient Egyptian art. This represents the interconnectedness of the biological (physical birth), social (many people present), and spiritual (symbols of protection above newborn), realms in this civilization (https://www.historyextra.com).

with personhood was a result of the belief that the "name provided an identity, and could also represent the person" (Hornung, 1992:178), as names "powerfully encompassed bodily, social, spiritual, and intellectual spheres" (Meskell, 2002:59).

If then, an individual was deemed alive in the womb and yet they did not achieve personhood, by way of naming, until birth, the initiation of one's introductory life stage becomes increasingly complex from a social point of view. Meskell notes the "Egyptian concept of personhood was multidimensional and was constituted of parts, not all of which were operational during life" (Meskell, 2002:58). Perhaps then, the best conclusion one can draw from the literature is that life in Ancient Egypt began in utero. However, complete personhood, and therefore their socially defined life stages, could only be achieved after birth. By this logic then, subadulthood would begin only after the birth of the individual and would therefore coincide with the act of naming, which solidified their identity and personhood.

2.10 SUBADULT DEATH IN ANCIENT EGYPT

Given the lack of modern medical techniques in Ancient Egypt, subadult mortality and premature death were frequent and expected occurrences. It does not come as a surprise then that a multitude of subadult cemeteries, have been discovered, and dated back to ancient times (Meskell, 2002). In an attempt to create an empirical dataset surrounding subadult mortality rates in Ancient Egypt, Robins estimated, using modern equivalency standards, that "20 percent of recognized pregnancies spontaneously failed, another 20 percent of all newborns died within the first year, and a further 30 percent did not survive beyond the age of five" (Robins, 1994:27-28). Although early death was not unexpected in ancient civilizations, the beliefs surrounding premature death are far less conclusive.

Some scholars have speculated that, given the frequency of premature death in Ancient Egypt (and many other cultures), parents and other family members did not allow themselves to become attached to their children, in order to alleviate the grief surrounding their potential loss (Meskell, 2002). Although Meskell's personal views differ, as will be clarified in the next chapter, she acknowledges that other scholars do not believe that subadults were viewed as valuable members of Ancient Egyptian society. This statement has been echoed by psychologists and anthropologists alike, stating that

"in countries where child mortality is currently high, the death of a child is often perceived as inevitable, with mourning lasting no more than a few days" (Young & Papadatou, 1997:197). Additionally, it has been proposed that "in general [not speaking specifically to Ancient Egypt], the death of a stranger, slave or child [would] go almost unnoticed, arousing no emotion nor ritual, since these individuals were not fully incorporated into the social order" (Hertz, 1960:76). Although in principle, these statements present logical coping mechanisms in the face of probable death, there is a plethora of physical evidence to suggest otherwise, including mummification. It should also be noted that grief and loss are perhaps the most illogical of emotions, as they are almost entirely visceral and innate reactions (Young & Papadatou, 1997:197).

In contrast to the propositions above, it has been reported that subadult Ancient Egyptian burials "demonstrate the care and concern given to children through a spectrum of ages, from neonates onwards [as]...[s]ignificant energy was expended upon [subadult] tomb construction and provisioning" (Meskell, 1999:131). Moreover, "[e]nsuring the survival of their offspring was obviously of great importance to most parents, many resorting to magical practices to guarantee their safety" (Meskell, 2000:429). It would then appear that subadults were not only perceived of as valuable members of society in life, but also in death. Meskell echoes this conclusion by explaining that the "mortuary evidence also reinforces that children were perceived as social beings who were also multiply constituted" (Meskell, 2000:425). The importance of subadults is further solidified by the fact that "children of all ages were given meaningful burials, rather than simply being disposed of expeditiously" (Meskell, 2000:429).

This is not to say however, that subadults were treated the same way as adults, as it has been inferred "that children were somehow perceived differently than adult members of the community, and were therefore not included in normative communal burial customs including funeral ceremonies and interment within public burial grounds" (Power, 2011:19). Notably, Power explicitly states that future projects, such as this very one, should conduct "detailed biocultural analyses of children's (and adults') physical remains [as the] physical remains appear to hold the greatest potential to access reflections of their life experiences throughout the life course" (Power, 2011:306). Therefore, this work will be compared and contrasted with Power's findings, as she

examined Ancient Egyptian subadults from the Early Dynastic Period to the Middle Kingdom, whereas the majority of individuals studied within this thesis are dated to the New Kingdom and later. Power's (2011) work likely represents the best comprehensive analysis of a single population of subadult Ancient Egyptians, (although her subjects were skeletonized rather than mummified), and will therefore be relied upon heavily within the Discussion Chapter of this project.

Moreover, the process of mummification, which is an elaborate, tedious and likely expensive endeavour, would then be an inherent indicator of elevated status. If the energy expenditure of the mortuary program is positively correlated with the love and worth attributed to the deceased, as Meskell (2000) suggests, it is evident that mummified subadults were essential members of society, who had indeed achieved 'personhood'. This view is further supported by the eight confirmed cases of mummification included in Power's (2011) dissertation. Only one of these individuals had a determinable sex, which was male (Power, 2011:114). Her findings suggested that subadults whether they were foetuses and infants or older were "equally as eligible to receive the most expensive technologically advanced forms of posthumous intervention" (Power, 2011:131). Although it can now be speculated that, given the existing literary evidence, that subadults were viewed as meaningful persons in Ancient Egypt, coming to understand the life stage divisions that existed between these individuals presents its own unique challenge.

2.10.1 MARKERS OF LIFE STAGES IN ANCIENT EGYPT: CLOTHING

The presence of at least some life stages in Ancient Egyptian culture becomes evident when one considers that "the actual age of the youngsters was [not necessarily] important, [what was important was] simply their stage in life" (Janssen & Janssen, 2007:23). This is to say that chronological age was perhaps at times not as important as the socially constructed age of the individual, which was likely defined by rites of passage. The former statement becomes problematic when one considers that these rites of passage tend to be correlated to chronological and/or developmental milestones (e.g. age of onset of menstruation) (Janssen & Janssen, 2007). Although social perceptions of age are certainly important and present in all societies, the biological elements that allow

for chronological aging are far more diagnostic. More on these 'coming of age' rituals will follow in a latter subsection of this work.

It has been suggested based on empirical evidence that the representation of life stages in the Ancient Egyptian written record was closely correlated to the presence or absence of clothing. As Janssen and Janssen (2007) illustrate, nudity in tomb or temple paintings during the Old Kingdom was largely reserved for the depiction of subadults up until the age of puberty (Figure 2.3). It must be noted however, that this representation of subadults was not consistent across time (Meskell, 2000).

The convention that associated subadults with nudity was not continued in the "Middle Kingdom [as] the children are more often dressed than not, wearing the same types of clothes as their elders [however their body size was much smaller, identifying them as subadults]" (Janssen & Janssen, 2007:23). It remains unclear if this shift in representation was a result of a change in the behaviour of the subadults themselves, or in response to an alteration in the artistic representation between the Old Kingdom and the New Kingdom, or if it was perhaps an indicator of the conscious recognition of life history stages. However, in the next time period, the "New Kingdom [saw] both nude and dressed children occur" (Janssen & Janssen, 2007:23). Although these findings, as interpreted from ancient illustrations, remain unclear, they further exemplify the ambiguity associated with interpretations of artistic conventions, life history stages in general, and how they are marked or reflected. The lack of definitive conclusions discussed above is emphasized

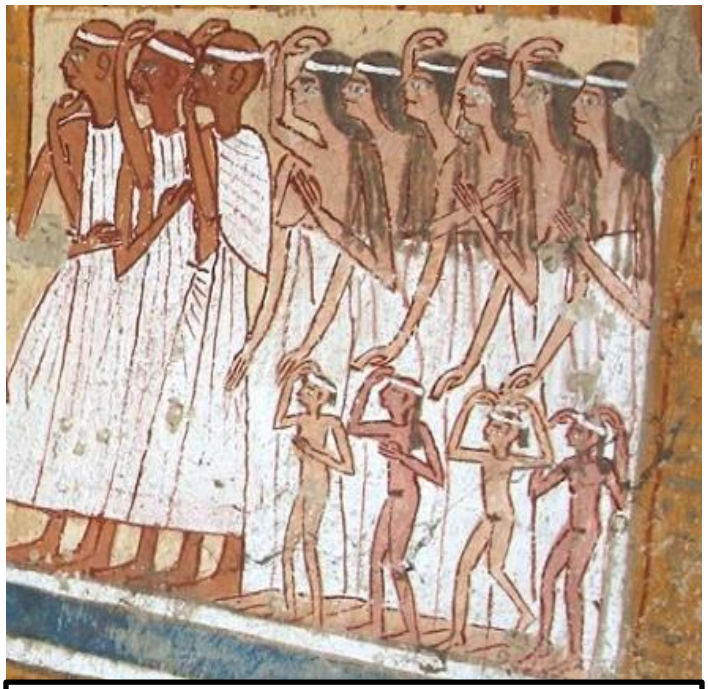

Figure 2.3 – Old Kingdom illustration denoting subadults by smaller body size and nudity (https//www.encyclopedia.com)

further when one considers the depiction of hairstyles as indicative of age in Ancient Egyptian drawings (Janssen & Janssen, 2007).

2.10.2 MARKERS OF LIFE STAGES IN ANCIENT EGYPT: HAIR

It should be stated that "rites which involve cutting something – especially the first haircut, the shaving of the head, [circumcision], and the rite of putting on clothes for the first time – [have often been observed to be generally indicative of] rites of separation (Van Gennep, 1960:53 - 54). It has been proposed that the hairstyle that an individual is depicted wearing in tomb or temple paintings may be used as a diagnostic marker of one's age stage (Fletcher, 1995). It appears as though "the most typical hairstyle of Egyptian children, boys as well as girls, was a braided plait with the end rolled up in an outward facing curl. It was worn on the right side, with the rest of the skull either shaved completely, or kept very short" (Janssen & Janssen, 2007:32). Although this particular style remained common across time, it was most commonly observed in images dating back to the Old Kingdom (Figure 2.4). A similar style appears in the Middle Kingdom "but with more variants such as a wide plait falling from the crown down onto the back, or more than one pigtail" (Janssen & Janssen, 2007:32). The New Kingdom also denotes a variant of this style, however it consisted of a "wide mop of hair at the right side" (Janssen & Janssen, 2007:32). Notably then, it appears as though both clothing and hairstyles increase in variability with time.

Figure 2.4 – Old Kingdom representation of a child exhibiting the proposed dominant subadult hair style (https://www.histclo.com).

Although theoretically, the fluid hairstyles across time should appear as a simple diagnostic tool for establishing age stages, one is left to wonder whether these depictions were factually representative of the entire community, or if they were perhaps the creative license of the artist at work. It is thought that "Egyptian infants wore their hair

in many ways, which changed during the course of time according to the dictates of fashion. There were also various styles present at the same time" (Janssen & Janssen, 2007:35). This statement is further supported by Joanna Fletcher's findings, which explain that the "sidelock is represented in both single and multiple form, in addition to completely shaven and cropped head and an occasional full head of hair (Fletcher, 1995:290). Additionally, Fletcher was able to determine that there were trends seen within hairstyles, which were unique to each dynasty, adding to the observed temporal variation. Some of the trends she observed led her to the conclusion that hairstyles may have denoted status differences at times, as royals and non-royals were illustrated with different hairstyles, particularly in the XVIII Dynasty (Fletcher, 1995). With that said, further exploration into this topic is necessary as generally speaking most individuals portrayed in art were thought to be of high status. Although illustrations of hairstyles do not establish a conclusive timeline surrounding Egyptian life stages, they may, in some situations, allude to elaborate and sexually dependent 'coming of age rituals'.

2.10.3 MARKERS OF LIFE STAGES IN ANCIENT EGYPT: WEANING

The age at which a subadult is no longer dependent upon its mother for nutrients in the form of breast milk, known as the age of weaning, may also be indicative of a life history stage transition within Ancient Egypt, as it is in most cultures (Dupras, Schwarcz & Fairgrieve, 2001). The age of breast feeding may be determined isotopically by the approximately three per mil trophic level enrichment in the nitrogen isotope ($\delta^{15}N$) that breastfeeding infants have over their mothers (Waters-Rist & Katzenberg, 2009). When the subadults are then given supplementary foods, which eventually entirely replace breast milk, their nitrogen enrichment depletes, lowering $\delta^{15}N$ levels, which is indicative of the individual being weaned (Waters-Rist & Katzenberg, 2009). Although it is not possible to complete isotope analysis given the non-invasive parameters of this particular example, earlier studies have contributed valuable information surrounding the age of weaning in Ancient Egypt (e.g. Dupras, Schwarcz & Fairgrieve, 2001).

A study was conducted surrounding Ancient Egyptian Roman Period weaning practices in 2001, which involved the examination of "49 infant and juvenile human remains from the Kellis 2 Cemetery in the Dakhleh Oasis, Egypt" (Dupras, Schwarcz & Fairgrieve, 2001:204). According to the isotopic analysis, it appears as though

individuals within this particular sample ingested "supplementary foods [which] were introduced around six months of age, while... breastfeeding continued for approximately the first three years of life" (Dupras, Schwarcz & Fairgrieve, 2001:211). This is consistent with Bogin's (2012) etically defined Infancy stage as it is characterized by the end of lactation, and therefore ends with the completion of weaning (Bogin, 2012).

2.11 COMING OF AGE RITUALS IN ANCIENT EGYPT

As a result of the lack of physical evidence for age stages in Ancient Egypt, a great deal of speculation regarding the interpretation of coming of age rituals exists. However, there is "evidence for puberty rituals such as male circumcision, in the textual and iconographic record" (Meskell, 1999:172). The act of circumcision is often indicative of a boy's transition from subadulthood into adulthood, which is why it was thought to have occurred around the pubertal age. This ritual appears to have been confirmed by the infamous tomb illustration from the *mastaba of Ankhmahor*, which has been dated to the Sixth Dynasty (Figure 2.5). If this painting is being interpreted correctly "the operation appears to have been an element, or perhaps the only rite, of a puberty ritual, constituting the [male] transition from infancy [or perhaps more accurately adolescence] into adulthood" (Janssen & Janssen, 2007:78). Although this particular conclusion may present over interpretation of the evidence, it does highlight the potential significance of both artistic illustrations and possible coming of age rituals.

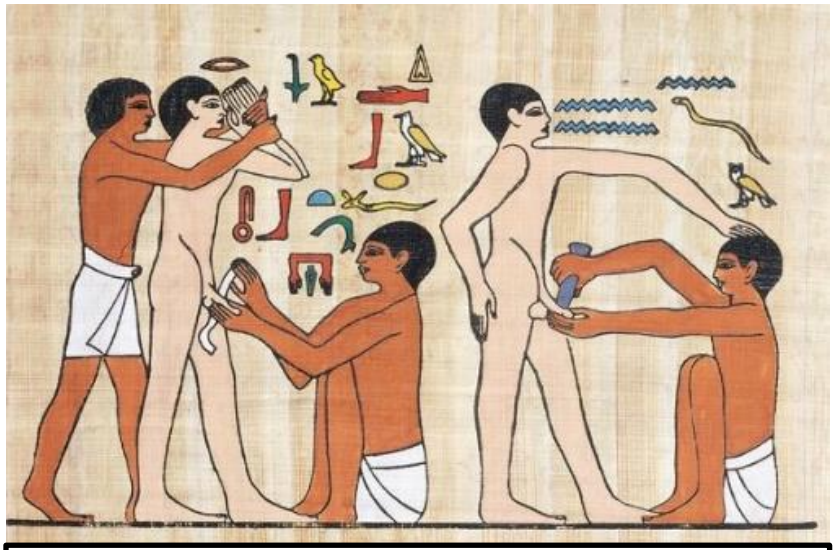

Figure 2.5 – Illustration of the *mastoba of Ankhmahor* representation of the male circumcision ritual (https://www.ancient-origins.net).

One would assume then that there should be an equivalent 'coming of age' ritual for female Ancient Egyptians. However, it should be noted that multiple Egyptologists

"suggest that life stages were more marked for men, as opposed to women" (Meskell, 2000, p.425). That being said, the onset of menstruation is a highly visible sign of puberty in females, of which there is no equally observable male equivalent. Notably, although it is not the only possible way to mark the onset of puberty, there is "no proof that clitoridectomy was performed on girls" (Janssen & Janssen, 2007:76). However, it has been speculated that women's rites of passage did not present as marked bodily modifications. The explanation for the demarcation of female age stages has been largely dominated by the premise that "girls were depicted in both iconography and material culture as sexual beings from an early age onwards" (Meskell, 2002:89). The sexualisation of the females could be observed in their artistic depictions, commonly involving enlarged breasts and precocious signs of puberty (Meskell, 2002). By extension then, the marked progression to sexual maturity would not have been as important for girls as it was for boys, given the early sexualisation of females in Egyptian culture.

Furthermore, Tames (2003) proposed that females transitioned into adulthood once they completed the sacrament of marriage, which was reinforced in the texts of Ani and Ankhshoshenq. These sacred texts contained information "about social maturity and marriageable ages – for girls it was around twelve or thirteen, whereas it was approximately twenty for boys" (Meskell, 2002:90). This proposition has been met with a great deal of contention however, given the fact that there is no evidence to suggest that marriage was regarded as sacred, with many believing it went entirely uncelebrated as it was primarily a contractual transaction (Bardis, 1967). Perhaps the most logical conclusion then is that the "transition to adulthood [was] a gradual progression that started much earlier than puberty itself" (Meskell, 2002:88), which suggests that these life stages were either not fixed or perhaps, in some cases the social determinants outweighed the physiological indicators. Throughout the remainder of this work the concepts from this chapter will be referenced and examined using a variety of methodological techniques that will be detailed in the following chapter.

CHAPTER 3

MATERIALS & METHODS: AN OVERVIEW

In order to create meaningful osteobiographies (cf Saul & Saul, 1989) for each of the individuals being studied in this work, it is important to assess a multitude of characteristics including their age and sex. This chapter presents a review of the many methods that will be used to establish such profiles on a broad scale initially, becoming more tailored to the scope of this particular project later in the chapter. Computed Tomography (CT), the medium through which most of the images used in this work were captured and viewed will be explained in detail, as will the applicability of each method to research conducted in the absence of a physical, tangible specimen. Finally, a comprehensive overview of the methods used to create osteobiographies from CT images, including the segmentation, windowing/levelling, and manipulation of said images will be provided.

No single method will be successful in accurately sexing ancient remains 100 percent of the time. Although pelvic traits have been determined to be the most consistent indicators of sex in adults (Buikstra & Ubelaker, 1994

Byers, 2002; Volk & Ubelaker, 2002; Bass, 2005), the amount of variation that exists within the human population, past and present, is not conducive to a 100% reliable method of sex estimation. The inherent ambiguity that accompanies sex estimation is then only further exacerbated when one considers estimating the sex of subadult remains, as most dimorphic characteristics only emerge in adolescence with the secretion of the sex hormones.

3.1 SEX ESTIMATION & SUBADULTS

Accurately estimating the sex of pre-pubescent subadults in the archaeological record verges on being entirely impossible in the absence of preserved mummified external genitalia (Morimoto, 1989), or sufficient aDNA. Each of the pelvic characteristics mentioned throughout this chapter are associated with the onset of sexual maturity, which typically occurs in modern populations between the ages of 9.7 and 14.1 years in females, or 13.7 and 17.9 years in males (Lee, 1980). This means that individuals who have not yet developed their dimorphic characteristics at the time of their death are remarkably difficult to sex. Fortunately though, many mummified individuals

retain their external genitalia, making this component of their biography accessible. Additionally, estimates of subadult age are far less complicated, which means that meaningful osteobiographies may be compiled for those who died prior to adulthood.

The term sexual dimorphism refers to the differences in size, colour, or other morphological traits between males and females of the same species (Frayer & Wolpoff, 1985). It should be noted that *Homo sapiens* are generally considered to have very limited sexual dimorphism relative to our primate cousins (Plavcan, 2012). The degree to which human sexual dimorphism may be observed does however vary from population to population (e.g. Relethford & Hodges, 1985; Rogers & Mukherjee, 1992; Iscan, 1995; Steyn & Iscan, 1999).

3.1.1 SEX ESTIMATION IN ADULTS: PHENICE CHARACTERISTICS

Phenice (1969) defined a trio of pelvic macroscopic morphological characteristics that are useful diagnostic markers of sex, boasting a reported 95% identification accuracy. The three features, which would come to be known collectively as the 'Phenice characteristics', were: the ventral arc, the subpubic concavity, and the medial aspect of the ischiopubic ramus (Lovell, 1989). Often, the subpubic angle is grouped with these diagnostic markers, although it is not considered one of the official Phenice characteristics. The subpubic angle refers to the angle present at the pubic arch, which is generally greater than 90° in females, and less than 90° in males (Phenice, 1969). For further information surrounding the intricacies of the Phenice method please refer to Phenice's original 1969 publication. Phenice argued that each of these traits were so evident that all people, not simply osteologists or anatomists, should be able to make sex classifications with 95% confidence (Phenice, 1969).

The validity of Phenice's ambitious claims have been tested multiple times in more recent decades (e.g. Lovell, 1989; Bruzek, 2002). Lovell (1989) created a study that involved the analysis of 50 adult pubic bones of known sex in which both experienced osteologists and those without anatomical knowledge were asked to sex the specimens according to the Phenice characteristics. Lovell's results suggested that the accuracy of the three previously mentioned anatomical features was closer to 83%, rather than Phenice's optimistic 95% (Lovell, 1989). With this method, the traits are scored as follows: "one" represents a characteristic indicative of a female, "two" represents an

ambiguous characteristic, and "three" indicates that the characteristic indicates a male (Buikstra & Ubelaker, 1994). It remains entirely possible that two of the three Phenice characteristics may score as threes while another may be more appropriately classified as a one, which of course creates an element of ambiguity. The premise of having indeterminate remains is not solely the product of the Phenice method, but rather it is a reality of human variability regardless of the technique used to sex human remains.

3.1.2 GREATER SCIATIC NOTCH

Although the Phenice method is perhaps the most widely recognized and applied technique in terms of sex estimation, additional methods have been proposed. One of the most notable additional sexing methods involves examining the shape of the deceased's greater sciatic notch (Buikstra & Ubelaker, 1994). Located inferior and posterior to the acetabulum, the greater sciatic notch tends to be markedly wider in females than it is in males (Singh & Potturi, 1978). The scoring of the greater sciatic notch is different from that of the Phenice characteristics in that it is scored along a five-point scale. Although it has been reported that this single characteristic allows for correct sex estimates up to 100% of the time (Singh & Potturi, 1978), there remains a great deal of speculation surrounding its true accuracy (Buikstra & Ubelaker, 1994).

3.1.3 CRANIAL MORPHOLOGY

Many scholars have endeavoured to establish accurate sex estimates based on cranial morphology (e.g. Hrdlicka, 1939; Krogman & Iscan, 1986). The cranial features that are generally considered for the estimation of sex are as follows: the nuchal crest, the mastoid process, the supraorbital margin, and the mental eminence (Buikstra & Ubelaker, 1994). Each of these features tends to be scored on a scale from one to five, ranging from female on the low end of the scale, to male on the high end (Buikstra & Ubelaker, 1994). Should the entire skull remain intact, the scores of each trait should be considered together in order to establish the most accurate estimation of sex, again emphasizing the importance of multifactorial analyses.

3.1.4 AGE ESTIMATION: AURICULAR SURFACE OF THE ILIUM

One adult age estimation method, first proposed by Lovejoy, Meindl, Pryzbeck, and Mensforth in 1985, involves scoring the chronological changes in the auricular surface of the ilium. Prior to the development of this technique, most of the adult age

estimations that occurred in archaeological contexts involved scoring the pubic symphysis or cranial sutures (Todd, 1920; Suchey, Brooks & Katz,1988; Buikstra & Ubelaker, 1994). Scoring of the pubic symphysis, although valuable, was often difficult to apply due to a combination of factors: the resolution of clinical CT scans being slightly too poor, the adherence of any remaining desiccated soft tissue obscuring a clear view at the pubic symphysis, and the fragility of the ancient remains as the bony material was commonly too damaged to accurately score. Therefore, this method is not included/explored further within this work (Buckberry & Chamberlain, 2002). Additionally, this becomes increasingly difficult, involving a high degree of segmentation expertise, to assess when working with CT images instead of tangible samples, adding to an already complex process. The auricular surface appears to be more resistant to taphonomic changes, making it useful for age estimations in ancient archaeological populations, although this study did not obtain reliable results using this method (Lovejoy et al., 1985).

The morphological alterations that occur along the auricular surface are positively correlated with increasing age (Buikstra & Ubelaker, 1994). These age specific changes are broken down into a set of eight age divisions, each with associated illustrations and descriptions, which allows researchers to match their specimen's auricular surface to that of one of the phases in order to obtain an age estimate (Lovejoy et al., 1985). Despite the respectable accuracy with which this method may apparently be applied, the technique has been said to be difficult to implement (Buckberry & Chamberlain, 2002). It was the difficult application of Lovejoy and colleagues' method, in combination with the scrutiny from Murray and Murray's 1991 work, which prompted Buckberry & Chamberlain's (2002) revised technique less than 20 years after Lovejoy et al.'s original publication. It should be stated that this revised method is still practiced in archaeological and forensic contexts and is therefore an instrumental component of composing meaningful adult osteobiographies. This unfortunately has not been formally studied in regard to CT images outside of this study, and so, this presents an interesting area for future research.

3.2 AGE ESTIMATION & SUBADULTS

In order to accurately estimate the age of subadult remains, many techniques have been proposed and applied. The most notable and recognized methods of age estimation

include epiphyseal fusion (e.g. McKern & Stewart, 1957; Franklin, 2010) and dental formation/eruption (e.g. Moorrees, Fanning & Hunt, 1963; Ubelaker, 1987; Hass et al., 1994). Given the fact that human growth and development tends to follow a predictable pattern these techniques should allow for some of the most precise age estimates. It should be explicitly stated that there are individual variances, population variances, and other confounding variables that may present as obstacles when creating age estimates. However, this study will remain cognizant of these factors and explicitly state their importance throughout the study. These techniques, amongst others, will be explored and reviewed throughout the remainder of this chapter, as making the most precise and credible age estimations possible is intrinsically important to this work.

3.2.1 EPIPHYSEAL & HAMATE HOOK FUSION

One of the most commonly used methods of age estimation in archaeological contexts is epiphyseal fusion (McKern & Stewart, 1957; Franklin, 2010). Colloquially known as "growth plates", the growing end of the shaft of a long bone fuses with the end of the bone, or the "metaphysis", once the individual bone finishes growth. Although the precise time at which each epiphysis fuses is somewhat variable across individuals, a general and reliable timeline for these fusion events has been established (Buikstra & Ubelaker, 1994). The fusion of each epiphysis, particularly those of the long bones, may be scored on a scale from zero to two where: "zero" represents no union, "one" represents partial union, and "two" represents the complete union of the diaphysis and epiphysis (Buikstra & Ubelaker, 1994). After complete fusion and dissolution of the epiphyseal line, very little morphological change occurs (Franklin, 2010).

A recently developed pubertal marker, which bears a great amount of similarity to the epiphyseal fusion method, has begun to gain the attention of scholars. This technique, first published by Lewis, Shapland and Watts in 2016, uses the completion of the hamate hook in the wrist as an indicator of puberty, an important developmental landmark, and therefore, to some degree, age. These scholars suggest that the carpal is fully formed approximately six months prior to the peak of the adolescent growth spurt, which they report occurs between ages 10 and 15 for females, and ages 16 and 18 for males in medieval populations (Lewis, Shapland & Watts, 2016). Although this method does not involve the fusion of an epiphysis, the formation of the hamate hook presents in

much the same manner. This particular method requires further exploration and analysis. However, it appears to be a promising tool within the realm of the assessment of developmental events. These methods are beneficial for the estimation of age in subadults, as epiphyses continue to fuse up until the mid 20s (Kreitner et al., 1998). After the complete union of the final epiphysis, which is typically the medial clavicle in the early 20s (Kellinghaus et al., 2010), this diagnostic aging technique is no longer useful.

3.2.2 LONG BONE LENGTHS

In addition to epiphyseal fusion, long bone diaphyses are highly valuable in terms of the information their metric analyses can provide. Multiple studies have been conducted across many populations, which have been able to estimate the age of subadults based on the length of long bone diaphyses (e.g. Ruff, 2007; Primeau et al., 2012; Primeau et al., 2016). Some such studies have been conducted using contemporary individuals of known age and sex in order to create standards (e.g. Hoffman, 1979; Black & Scheuer, 1996), whereas others have used archaeological remains in order to estimate age (e.g. Ubelaker, 1987; Wall, 1991), which is the case within this particular work.

There are confounding variables, which can be problematic in standardizing the growth rate of individuals. Consider that growth studies in archaeological populations are inherently cross-sectional and therefore "rates" of growth are subject to wide error ranges. Additional concerns include population level variability (e.g. some populations are generally larger in stature than others), individual variability (e.g. within a population there is great variability in individual height), and environmental influences (e.g. malnutrition influences the growth rate of individuals) (Lovejoy, Russel & Harrison, 1990). In addition to these variables, given the parameters of this work, it should be recognized that variability will exist between measurements taken from some radiological images and those of physical human remains, due to the magnification that exists within plain film X-ray images (Thompson & Nelson, 2000). Since these magnification factors were unknown for each X-rayed individual within this study, metric analyses were only included for CT scanned mummies because CT images are not subject to the same magnification as plain X-rays. With each of these influences in mind, the maximum diaphyseal lengths can be both informative and useful, primarily when they are a component of a multifactorial analysis including both epiphyseal fusion and dental

eruption. This tri-part analysis represents arguably the most holistic and meaningful method of archaeological subadult age estimation, which is why each of these methods will be applied individually and compared to one another within this work to establish the most accurate osteobiographical information possible.

3.2.3 DENTAL ERUPTION

Dental analysis has proven to be a valuable tool for both subadult and adult age estimation. The formation and eruption of both deciduous and permanent teeth is indicative of subadult age, as the crown and root of teeth develop at fairly regular rates during subadulthood (Moorrees, Fanning & Hunt, 1963; Ubelaker, 1987; Hass et al., 1994). Dental formation and eruption are therefore hugely valuable tools in the compilation of subadult osteobiographies. Although these age markers are accepted as reliable, there remains an inherent amount of human variation, which may lead to slightly inaccurate results, particularly when standards are developed for one population and applied to another (Hass et al., 1994). Typically, complete permanent crowns have formed by the age of fourteen years, at which point further age estimations based on dentition consider adult root and crown formation as well as tooth eruption (Moorrees, Fanning & Hunt, 1963; Ubelaker, 1987; Hass et al., 1994).

The formation of the roots belonging to the permanent teeth is said to occur up until the age of 35 years, however the changes after the age of 21 appear to be minor and likely unobservable macroscopically (Hass et al., 1994). Additional studies have attempted to analyze tooth wear patterns as an indicator of age (e.g. Lovejoy, 1985), however, there are numerous issues with this type of analysis. Given the fact that tooth wear patterns are heavily influenced by factors such as occupation and food choice, there are a multitude of confounding variables that render the proposed positive relationship between tooth wear and age unverifiable at best especially in Ancient Egyptians (Nelson & Kogon, 2020). Certainly then, the analysis of dental eruption and formation is a valuable contributor to the compilation of age estimations in subadults, especially considering that it is less subject to environmental effects than long bone lengths (Thompson & Nelson, 2000), however, additional techniques will likely be needed to establish meaningful age estimates for adults.

3.3 COMPUTED TOMOGRAPHY (CT)

Each year "300 million X-rays, CT scans, MRIs and other medical imaging exams are performed in the United States, and seven out of 10 people undergo some type of radiologic procedure" (Pickering, 2005:5439). Radiological imaging has come to be hugely important in clinical and archaeological contexts alike, with Computed Tomography (CT) being at the forefront of modern imaging technologies. Although many individuals have experienced these scans firsthand, the majority of people remain unaware of the non-clinical applications, processes, and innovations that have occurred surrounding these scanners in recent history. This work aims to provide an explanation of what exactly CT imaging is, how it works, how it has evolved throughout time, and how it remains relevant both within and beyond the 'traditional' medical setting, venturing as far as its application to the field of mummy studies. This technology has saved countless lives since its inception, while also allowing for further insight into the lives of past people in archaeological applications, which emphasizes just how invaluable CT scans have become.

3.3.1 WHAT IS CT?

Computed tomography is "radiography in which a three-dimensional image of a body structure is constructed by computer[s] from a series of plane cross-sectional images made along an axis" (e.g. Kalender, 2006:R30). Essentially, this means that first, multiple two dimensional (2D) images are taken, these are the 'x' plane and the 'y' planes, much like a drawing appears on paper. These images are then compiled, or stacked, into three-dimensional models, which include the 'z' plane, or the element of depth. Once the 3D volume is created, sophisticated software is able to reslice the volume in any way desired in order to examine the internal organs and structures within the human body in an entirely non-invasive, non-surgical manner, which is beneficial to individuals who are living, but also those who are deceased, or rather, those studying the deceased.

Furthermore, as internal organs are a different density than bone, they are easily distinguished from other structures on the basis of their attenuation of the X-ray beam as it passes through them throughout the CT scan (Goldman, 2007). Although plain film X-ray imaging is able to detect bones and organ tissues, superimposition of these structures

in 2D space is a fairly large obstacle to interpretation. CT scans are free of superimpositions, which allows for unobstructed and easily manipulated images to be obtained. In order to provide a perhaps more visually oriented definition of this radiological technique, consider that imaging internal bodily structures with CT is like "slicing a marble cake, which provides a detailed picture of just where the dark [i.e. organs] and light [i.e. bones] are distributed inside the cake" (Zenger, 2015:7). Essentially this technology creates a density dependent map of an individual's internal structures, which can prove to be highly valuable when attempting to diagnose if a patient has a tumour, or if an Ancient Egyptian mummy has been buried with imbedded amulets. Certainly, this technology has revolutionized, and continues to revolutionize, the scientific community, however it was not always as sophisticated as it is today.

3.3.2 COMPUTED TOMOGRAPHY & ARCHAEOLOGY

CT scans have been used for a multitude of purposes, which include the imaging of mummified individuals as well as "other archaeological artefacts such as clay, tablets, scrolls, pottery, bronze statues and swords" (Hughes, 2011:57). Following many early X-ray examinations of mummified remains by Sir Flinders Petrie, Grafton Elliot Smith, and Howard Carter in the late 1800s and early 1900s (Chhem & Brothwell, 2007), the development of CT scanning brought the potential for further non-destructive analysis of these human remains. CT scans are perhaps best suited for imaging mummified individuals given the fact that Magnetic Resonance Imaging (MRI) requires the presence of mobile protons (generally water), whereas mummified tissue has been desiccated or dehydrated, and ultrasounds tend to result in low resolution images, or a lack of image altogether (Cox, 2015). This is not to say that MRIs cannot be advantageous in mummy studies, as when performed using specialized software they can be very informative, particularly when examining the presence of resin (Nelson et al., 2012).

3.4 IMPACT RADIOLOGICAL DATABASE

As mentioned above, the CT scans that were examined throughout this work are stored in the Internet Mummy Picture Archiving and Communication Technology (IMPACT) Database. This valuable resource, developed by Dr. Andrew J. Nelson and Dr. Andrew Wade, represents a "large-scale, multi-institutional, collaborative research project devoted to the digital preservation and scientific study of mummified remains,

and the mummification traditions that produced them, using non-destructive medical imaging technologies" (Nelson & Wade, 2015:941). This database was created in order to "provide researchers with large-scale primary data samples for anthropological and paleopathological investigations" (Nelson & Wade, 2015:941). The development of this database makes projects such as this one possible, as it deviates from the traditional case-study approach to mummy studies in order to allow for a comprehensive, comparative analysis of a respectably sized sample population.

3.5 ORS^{si} VISUAL & DRAGONFLY SOFTWARE

The two primary software-processing tools that were used throughout this project are ORS^{si} Visual and Dragonfly Version 4.1. These programs were both developed by Object Research Systems (www.theobjects.com), a Montreal based company, and they may be used for a variety of applications including medical imaging technology, and as this project illustrates, some less conventional works. Dragonfly is a "software platform for the intuitive inspection of multi-scale multi-modality image data. Its user-friendly experience translates into powerful quantitative findings with high-impact visuals, driven by nuanced easy-to-learn controls" (Medical Imaging, 2020). ORS^{si} combines "an intuitive multilingual interface with real-time volumetric visualization...[it provides] rapid multi-user access to medical image data throughout an enterprise and from web browsers for true medical mobility" (Medical Imaging, 2020). ORS is targeted towards the medical community, whereas Dragonfly extends more towards the research based community.

Due to the fact that these software programs have similar functions, which are presented on unique interfaces, they both proved to be assets to this project. For the purpose of this work, Dragonfly allowed for more defined 3D images to be obtained, whereas ORS^{si} allowed for easier manipulation of the individual in 3D space, particularly in terms of obtaining measurements. Given these findings, both programs were used as outlined in the subsequent methodology sections, in order to create the most informed observations, which would then contribute to the most holistic and complete osteobiographies possible. It should also be noted that these software programs have been used in a multitude of scholarly publications within the field of Anthropology and

beyond (e.g. Bobyn et al., 2014; Guenounet al., 2015; Remy et al., 2017; Wade et al., 2019).

3.6 IMPACT SAMPLE POPULATION

A preliminary assessment of the mummies stored within the IMPACT database was conducted in order to establish exactly how many individuals were subadults. Using known provenience, previously suggested age estimations, and the careful examination of those of unknown age, it was determined that there were 21 individuals who were approximately 21 years of age or younger, qualifying them as subadults within the scope of this project (Table 3.1). Each of these individuals was then compiled into a list by their IMPACT identification number, any associated names and, where applicable, the CT scan specifics (e.g. slice thickness) (Table 3.1; Table 3.2; Table 3.3). In order to establish a comparative sample population, published literature was combed and consulted in order to gather a record of all of the known subadult Ancient Egyptian mummies not included within the sample population outlined in Table 3.1. The results of this compilation of comparative subadult individuals may be found in Appendix B.1.

Table 3.1 – Sample Population & Provenience: This table presents all of the miscellaneous provenience related findings documented throughout the study, which includes wrapping styles and any additional known provenience that could be documented on each individual. The information is sorted in chronological order.

IMPACT ID	Name	Period	Location	Additional Notes
IMP00082	Baka / Bahka / Bahkah	New Kingdom	Museum of World Treasures, Kansas, USA	Thought to be a Princess from Thebes, elaborately decorated wooden coffin with linen wrappings.
IMP00059	Liverpool Mummy 2 (M13997a)	Third Intermediate	Liverpool's World Museum, Liverpool, UK	Associated with the coffin of a Chantress belonging to the Temple of Amun.
IMP00031	Nesmut (ROM 910.268.1)	Third Intermediate	The Royal Ontario Museum, Toronto, Canada	Elaborately decorated coffin with inscription 'Lady of the House; Chantress of Amun-Re'.
IMP00021	Fleming Mummy	Third Intermediate	Robert Hull Fleming Museum, Vermont, USA	Highly fragmented remains, lower limbs excluded from scan.
IMP00056	Brussels Mummy E.09016	Late	Art & History Museum, Brussels, Belgium	Accompanying coffin is bearded (male), elaborately decorated, metal wiring found within body of mummy, possibly for articulation.
IMP00110	Keref	Late	National Museum of Antiquities, Leiden, Netherlands	Elaborately painted bearded coffin (male), linen wrappings with feet wrapped separately.
IMP00033	Brussels Mummy E.00452	Ptolemaic	Art & History Museum, Brussels, Belgium	Discovered in Al-Fayyum, linen wrappings in a crossover pattern with a painted faceplate.

IMP00069	Nesshutefnut	Ptolemaic	National Museum of Antiquities, Leiden, Netherlands	Liverpool Mummy 12 (13.12.05.34a), said to be male, gilded mask and linen wrappings coated with black resin.
IMP00124	Marischal Museum mummy (ABDUA: 22116)	Ptolemaic	Marischal Museum, Aberdeen, Scotland	Brown hempen swathings, one side coated in starch of rye, cartonnage of plaster and linen elaborately painted, said to be female.
IMP00115	Unnamed	Ptolemaic	National Museum of Antiquities, Leiden, Netherlands	Plaster coating on remains made analysis difficult due to the inability to separate it from bone, making long bone measurements impossible.
IMP00116	Unnamed	Ptolemaic	National Museum of Antiquities, Leiden, Netherlands	Plaster coating on remains made analysis difficult due to the inability to separate it from bone, making long bone immeasurable.
IMP00090	Mehit-em-Wesekht	Ptolemaic	Museum of New Zealand, Te Aro, New Zealand	Accompanying coffin elaborately decorated, thought to be the daughter of a priest at the Temple Min at Akhmim, coffin painted with faceplate, mummy wrapped in linen.
IMP00118	Unnamed	Roman	National Museum of Antiquities, Leiden, Netherlands	Plaster coating on remains made analysis difficult due to the inability to separate it from bone, making long bone measurements nearly impossible.
IMP00122	Herakleides	Roman	The J. Paul Getty Museum, California, USA	Elaborately adorned wrappings made of linen, faceplate of a young male accompanying remains.
IMP00117	Tasherytdjedhor / Sensaos	Roman	National Museum of Antiquities, Leiden, Netherlands	Neither femur is fully visible within scans and epiphyses are fractured, leading to diaphyseal measurements only.
IMP00064	Liverpool Mummy 7 (13.10.11.25)	Roman	Liverpool's World Museum, Liverpool, UK	Decorative wrappings with painted panel portrait, 13 layers of diagonal wrappings, CT scan completed, said to be male.
IMP00022	Little Girl from Thebes	Roman	Yale Peabody Museum, Connecticut, USA	Accompanying elaborately painted coffin of a women, said to represent the women the young girl would become in the afterlife.
IMP00004	Infant # 1 910.267.1	Unknown	The Royal Ontario Museum, Toronto, Canada	Metopic suture remains unfused, wrappings are made of linen.
IMP00055	Unnamed	Unknown	Art & History Museum, Brussels, Belgium	None
IMP00030	Unnamed	Unknown	Kunsthistorisches Museum, Vienna, Austria	None
IMP00114	Unnamed	Unknown	National Museum of Antiquities, Leiden, Netherlands	Partial remains only, assemblage includes both subadult and adult remains, only subadult remains scored.

Table 3.2: **Sample Population & Modality:** this table includes an overview of the radiological modality each of the twenty individuals being examined within this study were imaged with. Note that the modality 'FH' means First Hand analysis.

IMPACT ID	Date	Period	Name	Modality	Location
IMP00082	1300 BC	New Kingdom	Baka / Bahka / Bahkah	CT	Museum of World Treasures, Kansas, USA
IMP00059	943 - 715 BC	Third Intermediate	Liverpool Mummy 2 (M13997a)	X-ray	Liverpool's World Museum, Liverpool, UK
IMP00031	940 – 720 BC	Third Intermediate	Nesmut (ROM 910.268.1)	FH	The Royal Ontario Museum, Toronto, Canada
IMP00021	746 BC - 653 BC	Third Intermediate	Fleming Mummy	CT	Robert Hull Fleming Museum, Vermont, USA
IMP00056	747 - 525 BC	Late	Brussels Mummy E.09016	X-ray	Art & History Museum, Brussels, Belgium
IMP00110	664 - 525 BC	Late	Keref	CT	National Museum of Antiquities, Leiden, Netherlands
IMP00033	400 - 101 BC	Ptolemaic	Brussels Mummy E.00452	X-ray	Art & History Museum, Brussels, Belgium
IMP00069	332 BC	Ptolemaic	Nesshutefnut	X-ray	National Museum of Antiquities, Leiden, Netherlands
IMP00124	332 - 30 BC	Ptolemaic	Marischal Museum mummy (ABDUA: 22116)	X-ray	Marischal Museum, Aberdeen, Scotland
IMP00115	304 - 318 BC	Ptolemaic	Unnamed	CT	National Museum of Antiquities, Leiden, Netherlands
IMP00116	304 - 318 BC	Ptolemaic	Unnamed	CT	National Museum of Antiquities, Leiden, Netherlands
IMP00090	300 BC	Ptolemaic	Mehit-em-Wesekht	X-ray	Museum of New Zealand, Te Aro, New Zealand
IMP00118	30 BC - 640 AD	Roman	Unnamed	CT	National Museum of Antiquities, Leiden, Netherlands
IMP00122	30 BC - 640 AD	Roman	Herakleides	CT	The J. Paul Getty Museum, California, USA
IMP00117	109 AD	Roman	Tasherytdjedhor / Sensaos	CT	National Museum of Antiquities, Leiden, Netherlands
IMP00064	100 - 150 AD	Roman	Liverpool Mummy 7 (13.10.11.25)	X-ray	Liverpool's World Museum, Liverpool, UK
IMP00022	220 – 270 AD	Roman	Little Girl from Thebes	CT	Yale Peabody Museum, Connecticut, USA
IMP00004	Unknown	Unknown	Infant # 1 910.267.1	CT	The Royal Ontario Museum, Toronto, Canada

IMP00055	Unknown	Unknown	Unnamed	X-ray	Art & History Museum, Brussels, Belgium
IMP00030	Unknown	Unknown	Unnamed	X-ray	Kunsthistorisches Museum, Vienna, Austria
IMP00114	Unknown	Unknown	Unnamed	X-ray.	National Museum of Antiquities, Leiden, Netherlands

Nine of the individuals within the subset did not have an accompanying archaeological age estimate. Regardless of the presence or absence of an archaeological age estimate, the methods outlined in the previous sub sections were explicitly followed without reference to any existing information in order to ensure that unbiased osteobiographical assessments were made. This list was referenced solely for the IMPACT identification number, although the provided age and sex estimations were consulted upon the completion of each osteobiography in order to compare and contrast the findings of other scholars. The results of these comparisons will be discussed further in Chapter Five of this work.

3.7 METHODOLOGY: AGE ESTIMATION IN CT SCANNED INDIVIDUALS

As each of the ten CT scanned individuals mentioned in subsection 3.6 were examined, a very specific and consistent routine was followed to allow for a standardized procedure of examination. First, both ORS^{si} and Dragonfly software were synchronously launched and the appropriate dataset of radiological images for the subadult mummy being studied was uploaded onto each software program. At this point careful windowing and levelling, was completed in both programs in order to separate any wrappings and soft tissue materials from the bones of the deceased. Windowing and levelling allows for the separation of materials based on their attenuation coefficient, with bone, enamel, and the occasional grave good representing some of the more dense materials, while wrappings and soft tissue represent the less dense materials.

Table 3.3: **Sample Population & Radiological Metrics** this table provides the specific parameters of each of the ten CT scanned individuals within this study population. Due to the lack of known parameters in X-rayed mummies, they were omitted from this table. Note that kVp or kilovoltage peak refers to the maximum potential applied to the X-ray tube (Hurwitz et al., 2009). mA refers to the tube current (Hurwitz et al., 2009). Thickness refers to how thick (mm) each CT slice is, the thinner the slice, the higher the resolution. Note that 'UK' represents 'unknown'.

IMPACT ID	Date	Name	kVpm	mA	Thickness (mm)	CT Model	Year Scanned
IMP00082	1300 BC	Baka / Bahka / Bahkah	120	315	0.625	Lightspeed 16	2011
IMP00021	746 BC - 653 BC	Fleming Mummy	120	382	3.000	iCT 128	2010
IMP00110	664 - 525 BC	Keref	120	225	1.300	Mx8000	2000
IMP00115	304 - 318 BC	Unnamed	120	200	1.300	MxTwin	2000
IMP00116	304 - 318 BC	Unnamed	120	225	1.300	Mx8000	2000
IMP00118	30 BC - 640 AD	Unnamed	120	150	1.100	MxTwin	2000
IMP00122	30 BC - 640 AD	Herakleides	120	137	2.000	Sensation 16	2005
IMP00117	109 AD	Tasherytdjedhor / Sensaos	120	100	1.300	AVE1	1997
IMP00022	220 – 270 AD	Little Girl from Thebes	120	170	2.000	Toshiba MEC CT3	2010
IMP00004	Unknown	Infant # 1 910.267.1	100	340	1.250	Lightspeed VCT	2007

After a clear image of each of the individuals' long bones was obtained, which involved manipulating the oblique axes to ensure appropriate visualization, the 'ruler' annotation tool was selected. The ruler tool, within the ORS^{si} program, was used in order to take both diaphyseal and epiphyseal long bone lengths wherever possible (Figure 3.1). The diaphyseal length involves the measurement of only the bone shaft, whereas the epiphyseal length, sometimes referred to as the max length, represents the maximum measurement of the bone with epiphyses in place (Lovejoy, Russel & Harrison, 1990). In the event that the long bones could not be accurately measured due to fragmentation or a lack of visibility this was noted on the checklist. A thorough overview of these limitations will be provided in the Discussion Chapter of this work.

Once the bilateral measurements for the left and right humerus, radius, ulna, femur, tibia, and fibula were completed and recorded on the checklist, which was tailored specifically for this project (Appendix B.2), additional features that allow for age estimation were examined. Relying again upon the windowing and levelling process, as

well as the magnification tool, each of the major epiphyses was examined for their degree of fusion. If any of these could not be scored due to a lack of visibility, fragmentation, or another confounding variable this was noted as 'indeterminate' on the checklist. The final component of bone related age estimation, the hamate hook, was then located and examined for fusion bilaterally. In the event that the hamate could not be distinguished, was fragmented, or was missing altogether, this was scored as being 'Indeterminate' (I) on the checklist.

Upon completion of this section of the checklist, the dentition of each individual was explored. Windowing and levelling generally allowed for a clear image of the teeth, given the exceptionally high density of enamel. Using the 'Dental Inventory Visual Recording Chart' from Hass, Buikstra, Ubelaker & Aftandilian's 1994 publication of *Standards for Data Collection in Human Skeletal Remains* (Appendix B.3), the dental eruption and completion was recorded.

Figure 3.1: IMP00021 displaying the 'ruler' feature tool on ORS^{si} from the IMPACT database (Graves, 2020).

Once the age component of the osteobiography had been completed, known standards for long bone length (e.g. Maresh, 1955; Thompson & Nelson, 2000; Ruff, 2007), epiphyseal fusion (e.g. McKern & Stewart, 1957; Franklin, 2010), and dental formation/eruption (e.g. Moorrees, Fanning & Hunt, 1963; Ubelaker, 1987; Hass et al., 1994) were consulted in order to establish age range estimations for each subadult.

3.8 METHODOLOGY: AGE ESTIMATION IN X-RAYED INDIVIDUALS

It was far more difficult to obtain meaningful results when working with ten X-rayed individuals for a variety of reasons, all of which will be detailed within the 'Limitations' section of this work in Chapter Six. The procedure that was used in order to procure appropriate data was far more simplistic than that of the CT scanned

individuals. The plain film images of each mummy were opened and observed, using tools such as 'zoom' to view as much detail as possible. Metric data in terms of long bone length could not be obtained due to the unknown magnification factor that exists in these radiological images. What could be viewed in some of the X-rays were unfused epiphyses, which were recorded accordingly. Similarly, the hamate hook was occasionally observable in X-rayed individuals and was again scored appropriately.

Upon the completion of this component of the checklist, the dentition was analyzed for further indicators of age. Fortunately, due to the density of enamel, teeth were largely observable in X-rayed individuals. Using the 'Dental Inventory Visual Recording Chart' from Hass, Buikstra, Ubelaker & Aftandilian's 1994 publication of *Standards for Data Collection in Human Skeletal Remains* (Appendix B.3), the dental eruption and completion was recorded. Once the age component of the osteobiography had been completed, known standards for epiphyseal fusion (e.g. McKern & Stewart, 1957; Franklin, 2010), and dental formation/eruption (e.g. Moorrees, Fanning & Hunt, 1963; Ubelaker, 1987; Hass et al., 1994) were consulted in order to establish age range estimations for each subadult.

3.9 METHODOLOGY: SEX ESTIMATION IN CT SCANNED INDIVIDUALS

In order to complete the osteobiography of each CT scanned subadult, the remains were then examined for indicators of sex. First, when it was possible to obtain a clear image of the external genitalia (e.g. Morimoto, 1989), this was used as an obvious diagnostic marker. Whenever it was possible to visualize the pelvis, the greater sciatic notch was then scored, as was the subpubic angle, unless this remained inconclusive. This was generally possible using the windowing and levelling tool, and reorienting the oblique axes, however when these features could not be detected due to fragmentation or a lack of visibility, this was recorded on the checklist.

When completing the analysis of the auricular surface and pubic symphysis further, more detailed procedures were required. In order to visually find these features the 'segmentation' tool within ORS^{si} was employed, which allows for the selection of a particular region of interest (ROI) within the CT scan. In order to define this ROI, the highlighting feature was selected and, when possible, the pelvis alone was highlighted for further study. Often, however, it was not possible to isolate the pelvis, which meant that

using the ‘picking’ tool in order to remove all of the surrounding bony material was required. This tool allows for the removal of any components of the scan that are not within the ROI. Once the pelvis had been isolated, the ‘extraction’ feature was used in order to visualize the ROI in 3D space and make the appropriate observations regarding both the sulcus and the pubic symphysis. Although many attempts were made to gather conclusive findings from both the auricular surface and the pubic symphysis, the results were not deemed reliable enough to contribute to the overall estimates within this work.

Each of these factors was then considered in order to create a sex estimation for every individual, however when a conclusive result could not be obtained sex was recorded as ‘indeterminate’, which was often the case particularly in the younger, prepubescent subadults who lacked visible external genitalia.

3.10 METHODOLOGY: SEX ESTIMATION IN X-RAYED INDIVIDUALS

Much like age estimates, accurate sex estimates in X-rayed individuals were far more difficult to procure in comparison to their CT scanned counterparts. When it was possible to observe external genitalia on X-rays, which did occur, this was the first recorded observation. Following this, the pelvis became the focal point, which often involved zooming in on this region of interest. When possible, which was unfortunately infrequently the case, the greater sciatic notch and subpubic angle were then scored. Scoring of the pubic symphysis and preauricular sulcus could not be completed in X-rayed individuals due to the positioning of the innominates and an inability to observe the textures on the surface of the bone. The external genitalia, greater sciatic notch and subpubic angle were then considered in order to create a sex estimation for every individual. However when a conclusive result could not be obtained sex was recorded as ‘indeterminate’, which was most often the case particularly in the X-rayed individuals who lacked observable external genitalia. The results were then compared to published sources, when available, in order to confirm and contrast these findings.

3.11 METHODOLOGY: MISCELLANEOUS ANALYSES

After the completion of the osteobiographical information surrounding age and sex, the diagnostic markers of mummification were examined and recorded. These features included excerebration (the breaking of the cribriform plate of the ethmoid, excerebration, the presence of resin in the cranium) and evisceration. In order to explore

whether the cribriform plate had been broken, which was often indicative of excerebration, meaning the removal of the brain, the CT scan was arranged using Dragonfly so that the top of the skull was in view using the 3D model, presenting a top-down view. At this point, the 'clipping box' was used to slice down into the skull until the contents within (e.g. residual brain tissue and/or resin) and the cribriform plate were visible. Windowing and levelling was used in order to adjust the image for the best possible visibility of these features. Similarly, in order to determine if the individual had been eviscerated, the 3D CT was manipulated in Dragonfly until the abdomen was visible. Windowing and levelling was then used to distinguish any remaining soft tissue, which would indicate the presence of residual organs, and therefore the lack of evisceration. Alternatively, windowing and levelling would be used to visualize packing, which was often inserted after the act of evisceration. Should any of these features not be distinguishable this was also recorded on the checklist.

Additional miscellaneous features were then examined in order to complete the most thorough osteobiography possible for each subadult. These features included the wrappings the individual was presented wearing, the head and limb positioning, any pathological lesions, the presence of absence of hair, and the presence or absence of grave goods. Each of these features was examined using both ORS^{si} and Dragonfly in order to make the most informed observations possible. Pathological lesions were only included when they could definitively be discerned as pre-mortem, rather than post-mortem breakage, taphonomic changes, or shifting of the remains. In order to detect hair, wrappings, and grave goods, windowing and levelling were used, as the latter two features are less dense than bone, whereas grave goods were often very dense.

Upon the completion of each of the 21 diagnostic checklists, the data were compiled into an Excel spreadsheet for comparative analyses. The individuals were sorted by age initially, and where applicable, temporal and geographical divisions in order to establish any trends that may exist within the sample population. This spreadsheet allowed for easy manipulation of the data, as well as comparisons on both the individual and population level. The life history stage per Bogin (2012), was also included on this spreadsheet (Appendix B.4). The findings of these observations and the associated analyses will be presented within the subsequent results chapter of this work.

CHAPTER 4

RESULTS: SUBADULTHOOD IN ANCIENT EGYPT

This chapter will explore this study's results according to three relevant categorical variables: sex, age, and temporal variation. Additional tables will be presented, which will include the results of inquiries regarding mummification styles across time, mortuary positioning of the head and limbs across time, and any miscellaneous findings that presented during the examination. These additional data tables allow the reader to have a comprehensive picture of each of the assembled osteobiographies, while also ensuring the complete transparency of the study.

4.1 SEX, SUBADULTHOOD & MORTUARY TREATMENT

As seen in Table 4.1, which has been sorted according to the sex estimate of the individuals, there seems to be a correlation between age and sex within this study population. Generally speaking, the males tended to be younger than their female counterparts. The males, including the probable and suggested males (n = 9), presented an age range at death of approximately 7.7 years. This is in comparison to the females (n= 9), including the probable and suggested females, who presented an average age at death of approximately 12.4 years. This was calculated using the median values within the age estimation range (e.g. if the age estimate was 3 – 6 years, the median value of 4.5 was used in the calculation), in combination with the figure that was used to indicate that the individual was greater or less than a concrete value (e.g. if the age estimate was X < 10 years, the value of 10 was used in the calculation).

These findings are echoed in the sample of other known subadult Ancient Egyptian mummies drawn from the literature. This sample includes individuals from the Middle Kingdom on, but they are primarily from the Ptolemaic and Roman Periods (Appendix B.1). Of the 75 subadult Ancient Egyptian mummies known to this author, not included in this focal sample, there were 31 males, 16 females, and 28 individuals of unknown sex. Of these mummies, the average male age at death is 7.4 years, whereas the average female age at death is 10.5 years, which is consistent with the findings of this thesis. Additionally, there are 14 male subadults under the age of five years, whereas there are zero females under the age of five years at the time of their death. These findings further support the hypotheses put forth in this thesis.

Table 4.1 – Osteobiographical Findings: All of the observations made regarding the sex estimate for each of the individuals within this study population are presented in this table. Note, the modality 'FH' is indicative of First Hand analysis. This table should be interpreted as follows: 'I' represents 'Indeterminate', 'M' represents 'Male', 'PM' represents 'Probable Male', 'F' represents 'Female' and 'PF' represents 'Probable Female'. Note that 'suggested' simply refers to individuals who had been previously studied and assigned a likely sex, however the sex could not be observed to a point where the author of this thesis felt justified in assigning a 'probable' estimate.

IMPACT ID	Name	Modality	Greater Sciatic Notch	Subpubic Angle	External Genitalia	~ Age (years)	Sex Estimation
IMP00004	Infant # 1 910.267.1	CT	I	I	M	< 1	M
IMP00116	Unnamed	CT	I	I	M	3 - 6	M
IMP00118	Unnamed	CT	I	I	M	1 - 2	M
IMP00055	Unnamed	X-ray	I	I	M	8 - 10	M
IMP00056	Brussels Mummy E.09016	X-ray	I	I	M	8 - 10	M
IMP00122	Herakleides	CT	4 / PM	< 90°	Absent	18 - 21	PM
IMP00110	Keref	CT	I	I	Absent	3 - 6	I / Suggested Male
IMP00064	Liverpool Mummy 7 (13.10.11.25)	X-ray	I	I	Absent	3 - 6	I / Suggested Male
IMP00069	Nesshutefnut	X-ray	I	I	Absent	14 - 18	I / Suggested Male
IMP00022	Little Girl from Thebes	CT	I	I	F	2 - 4	F
IMP00031	Nesmut (ROM 910.268.1)	FH	I	I	F	6 – 8	F
IMP00082	Baka / Bahka / Bahkah	CT	1 / F	> 90°	Absent	> 18	F
IMP00030	Unnamed	X-ray	I	I	F	< 10	F
IMP00059	Liverpool Mummy 2 (M13997a)	X-ray	1 / F	> 90°	Absent	15 - 21	F
IMP00090	Mehit-em-Wesekht	X-ray	2/ PF	> 90°	Absent	14 – 18	F
IMP00021	Fleming Mummy	CT	2 / PF	> 90°	Absent	12 - 15	PF
IMP00117	Tasherytdjedhor / Sensaos	CT	2 / PF	> 90°	Absent	14 - 18	PF
IMP00124	Marischal Museum mummy (ABDUA: 22116)	X-ray	I	I	Absent	< 10	I / Suggested Female
IMP00115	Unnamed	CT	I	I	Absent	3 - 6	I
IMP00033	Brussels Mummy E.00452	X-ray	I	I	Absent	6 - 8	I
IMP00114	Unnamed	X-ray	I	I	Absent	< 10	I

Furthermore, it should be noted that it was far more common for male external genitalia to be preserved and identifiable in the radiological imaging. Five out of nine (55.6%) assumed males presented with preserved reproductive organs, which were highly

visible, particularly on CT scans (Figure 4.1). This is in comparison to the three females out of an assumed nine (33.3%), who presented with observable female reproductive organs. The presence of external genitalia was used as a conclusive diagnostic indicator of sex, which allowed for formal sex estimations (e.g. 'Male' instead of 'Probable Male'). In the absence of external genitalia, formal sex estimations were only presented in individuals who had surpassed the age of secondary sexual characteristic development in combination with a conclusive osteobiographical assessment (e.g. IMP00082, her greater sciatic notch score in combination with her subpubic angle and an age greater than 18 years allows for a fixed age assessment of female). Finally, the auricular surface and pubic symphysis scores, although recorded, were not presented due to the overwhelming number of indeterminate findings associated with these methods. These scores were impossible to obtain in plain film X-rays and were often inconclusive on CT scans due to postmortem fragmentation of the remains.

4.2 ESTIMATING SUBADULT AGE

As previously mentioned, three separate age estimation methods were employed throughout this thesis in order to present the most comprehensive osteobiographical assessment possible. Each of these methods, epiphyseal fusion (McKern & Stewart, 1957), long bone lengths (e.g. Maresh, 1955), and dentition (Moorrees, Fanning & Hunt, 1963; Ubelaker, 1987; Hass et al., 1994), will be presented in separate results tables. However, it should be noted that the age estimates they provide independently are consistent with one another, providing a degree of validation and credibility to these estimates. It should be stated that when using Maresh's (1955) study, a correction factor was applied to the measurements due to the magnification that was

Figure 4.1: A CT image illustrating the presence of IMP00116's preserved external male genitalia (Graves, 2020).

present on the roentgenograms. The magnification was reported to be between 1.0% and 1.5% (Maresh, 1955: 725), and was therefore corrected for at a mean value of 1.25%.

4.2.1 ESTIMATING SUBADULT AGE: EPIPHYSEAL FUSION

First, as outlined in the Methodology section of this work, the degree of epiphyseal fusion at five major long bone epiphyses was examined. Additionally, the hamate hook, an indicator of the successful initiation of the adolescent growth spurt, was also assessed (Lewis, Shapland & Watts, 2016). The results of these analyses are presented below in Table 4.2, which has been sorted in chronological order from youngest to eldest.

Table 4.2 – Epiphyseal Fusion Findings: This table includes the epiphyseal fusion states of each relevant long bone within each individual. Note, the modality 'FH' is indicative of First Hand analysis. This table should be interpreted as follows: 'U' represents 'unfused', 'I' represents 'Indeterminate', 'P' represents 'Partial' fusion and 'F' represents 'Fused'. The fibula was omitted as the results were almost entirely inconclusive due to the excessive fragmentation of this bone across the individuals. For further details regarding the scoring techniques used to procure these results, see Chapter Three.

IMPACT ID	Name	Modality	Femoral Head	Distal Femur	Distal Tibiae	Humeral Head	Medial Clavicle	Hamate Hook	~ Age (years)
IMP00004	Infant # 1 910.267.1	CT	U	U	U	U	U	U	< 1
IMP00118	Unnamed	CT	U	U	I	U	I	U	1 - 2
IMP00022	Little Girl from Thebes	CT	U	U	U	U	U	U	2 - 4
IMP00110	Keref	CT	U	U	U	U	U	I	3 - 6
IMP00115	Unnamed	CT	U	U	U	U	I	I	3 - 6
IMP00116	Unnamed	CT	I	I	I	I	I	I	3 - 6
IMP00064	Liverpool Mummy 7 (13.10.11.25)	X-ray	I	U	U	U	U	I	3 - 6
IMP00031	Nesmut (ROM 910.268.1)	FH	I	I	I	U	U	I	6 - 8
IMP00033	Brussels Mummy E.00452	X-ray	U	U	U	U	I	I	6 - 8
IMP00055	Unnamed	X-ray	U	U	U	U	U	I	8 - 10

IMP00056	Brussels Mummy E.09016	X-ray	U	U	U	U	U	I	8 - 10
IMP00030	Unnamed	X-ray	U	U	U	U	U	I	< 10
IMP00114	Unnamed	X-ray	U	U	U	U	U	I	< 10
IMP00124	Marischal Museum mummy (ABDUA: 22116)	X-ray	U	U	U	U	I	I	< 10
IMP00021	Fleming Mummy	CT	U	I	I	U	U	I	12 - 15
IMP00117	Tasherytdjedhor / Sensaos	CT	U	U	U	U	U	I	14 - 18
IMP00069	Nesshutefnut	X-ray	I	P	P	U	U	I	14 - 18
IMP00090	Mehit-em-Wesekht	X-ray	P	P	P	P	U	F	14 - 18
IMP00059	Liverpool Mummy 2 (M13997a)	X-ray	F	P	P	P	U	I	15 - 21
IMP00122	Herakleides	CT	F	F	P	P	P	F	18 - 21
IMP00082	Baka / Bahka / Bahkah	CT	F	I	F	F	P	I	> 18

4.2.2 ESTIMATING SUBADULT AGE: LONG BONE LENGTHS

In addition to epiphyseal fusion, the lengths of five long bones were recorded in each CT scanned individual, using the 'ruler' tool in ORS^{si} (Figure 3.1). These results are presented in Table 4.3, which is sorted according to chronological age, from youngest to oldest. Due to the unknown magnification factors present within the X-ray images, the individuals who were X-rayed using only plain film could not contribute to the results.

Table 4.3 – Long Bone Length Measurements: This table includes the long bone lengths of relevant long bones within each individual. The fibula was omitted as the results were almost entirely inconclusive due to the common fragmentation in this bone across the individuals. Measurements were taken bilaterally whenever possible with L indicating the left side and R indicating the right. Note that the * indicates that the measurement was of diaphyseal length, whereas those without the asterisk are measurements of epiphyseal length. The modality 'FH' is indicative of First Hand analysis. These results consulted the work of Maresh (1955) and Ruff (2007) for comparative age estimates according to long bone lengths.

IMPACT ID	Name	Modality	Humeri (cm)	Femura (cm)	Tibiae (cm)	Radii (cm)	Ulnae (cm)	~ Age (years)
IMP00004	Infant # 1 910.267.1	CT	L 6.8* R 6.9*	L 8.5* R 8.5*	L 6.7* R 6.7*	L 4.6* R 4.6*	L 4.6* R 4.6*	< 1
IMP00118	Unnamed	CT	I	L 11.9* R 12.1*	I	I	I	1 - 2
IMP00022	Little Girl from Thebes	CT	L 11.1* R: 10.9*	L 13.5* R 13.7*	L 117.8* R 118.2*	I	I	2 - 4
IMP00110	Keref	CT	L 12.0* R 12.2*	L 17.6* R 17.7*	L 13.8* R 13.9*	L 10.2* R 10.0*	L 10.1* R 10.0*	3 - 6
IMP00115	Unnamed	CT	I	I	I	I	I	3 - 6
IMP00116	Unnamed	CT	I	I	I	I	I	3 - 6
IMP00031	Nesmut (ROM 910.268.1)	FH	L 20.3* R 20.5*	L 28.9 R 28.8	L 24.3 R 24.4	L I R 23.8	L 15.0 R I	6 - 8
IMP00021	Fleming Mummy	CT	L 30.7 R 30.7	I	I	I	I	12 - 15
IMP00117	Tasherytdjedhor / Sensaos	CT	I	I	L 28.0* R 28.1*	L 16.9* R 17.0*	L 17.2* R 17.3*	14 - 18
IMP00122	Herakleides	CT	L 30.5 R 30.6	L 46.0 R 46.0	L 36.0 R 36.4	L 24.1 R 24.1	L 23.8 R 23.9	18 - 21
IMP00082	Baka / Bahka / Bahkah	CT	L 28.3 R 28.2	L 42.7 R 41.7	L 32.5 R 32.0	L 18.9 R 18.8	L 20.4 R 20.5	> 18

4.2.3 ESTIMATING SUBADULT AGE: DENTITION

The final age estimation method, which is also likely the most accurate, involved the examination of dental eruption as well as crown and root formation (Moorrees, Fanning & Hunt, 1963; Ubelaker, 1987; Hass et al., 1994). The results of this analysis are presented in Table 4.4, which has been sorted according to ascending chronological age. Due to the density of enamel, teeth are visible on plain film X-rays and therefore all of the individuals within the study population were assigned age estimates. When the dentition could not be observed due to overlapping elements, or poor X-ray quality, this was also documented.

Table 4.4 – Dental Eruption & Age Estimation: This table reflects the observations regarding the dentition of each of the individuals within the study population. The dental eruption is then used as a major contributor to the age estimate component of each respective osteobiography. Note, the modality 'FH' is indicative of First Hand analysis.

IMPACT ID	Name	Modality	Dental Findings	~ Age (years)
IMP00004	Infant # 1 910.267.1	CT	Deciduous dentition only, partial eruption of incisors.	< 1
IMP00118	Unnamed	CT	Deciduous dentition only, eruption of incisors and canines, crown formation of remaining teeth.	1 - 2
IMP00022	Little Girl from Thebes	CT	Deciduous dentition only, permanent first molar crown formation present.	2 - 4
IMP00110	Keref	CT	Deciduous dentition only, permanent first and second molar crown formation present.	3 - 6
IMP00115	Unnamed	CT	Deciduous dentition only, permanent first and second molar crown formation present.	3 - 6
IMP00116	Unnamed	CT	Deciduous dentition only, permanent first and second molar crown formation present.	3 - 6
IMP00064	Liverpool Mummy 7 (13.10.11.25)	X-ray	Deciduous dentition only, permanent first and second molar crown formation present.	3 - 6
IMP00031	Nesmut (ROM 910.268.1)	FH	Mixed dentition, eruption of first permanent incisors/molars.	6 - 8
IMP00033	Brussels Mummy E.00452	X-ray	Mixed dentition, eruption of first permanent incisors/molars.	6 - 8
IMP00055	Unnamed	X-ray	Deciduous canines present, permanent incisors and first molars erupted, second molars show crown and root formation.	8 - 10
IMP00056	Brussels Mummy E.09016	X-ray	Deciduous canines present, permanent incisors and first molars erupted, second molars show crown and root formation.	8 - 10
IMP00030	Unnamed	X-ray	Mixed dentition, molars unerupted, poor quality X-ray.	< 10
IMP00114	Unnamed	X-ray	Skull not included in X-ray.	< 10
IMP00124	Marischal Museum mummy (ABDUA: 22116)	X-ray	Dentition cannot be observed due to X-ray quality.	< 10
IMP00021	Fleming Mummy	CT	Permanent dentition erupted except third molars, crown formation of left maxillary third molar present.	12 - 15
IMP00117	Tasherytdjedhor / Sensaos	CT	Permanent dentition erupted except third molars, crown and root formation of third molars present.	14 - 18
IMP00069	Nesshutefnut	X-ray	Dentition cannot be observed due to X-ray quality.	14 - 18
IMP00090	Mehit-em-Wesekht	X-ray	Permanent dentition erupted except third molars, crown and root formation of third molars present.	14 - 18
IMP00059	Liverpool Mummy 2 (M13997a)	X-ray	Permanent dentition, third permanent molars partially erupted.	15 - 21
IMP00122	Herakleides	CT	Permanent dentition erupted in its entirety.	18 - 21
IMP00082	Baka / Bahka / Bahkah	CT	Permanent dentition erupted except left mandibular third molar, perhaps due to agenesis.	> 18

4.3 SUBADULT AGE & BOGIN'S LIFE HISTORY STAGES

Once the subadult age estimates had been established, each individual was assigned to the appropriate life history stage according to Bogin (2012). Fortunately, the findings of each aging technique agreed with one another leading to more reliable results (i.e. dental age estimates agreed with epiphyseal fusion scores and long bone lengths for

each individual). As Table 4.5 illustrates, there is no observable trend seen between the time period and the life history stage. As mentioned previously, the most notable trend is that males within this study population seem to be younger at their time of death, appearing within the Infancy, Childhood, and Juvenile life history stages. The females however, tend to be older at their time of death, corresponding largely to the Juvenile, Adolescence, and Adulthood life history stages.

Table 4.5 – Bogin's Life History Stages according to Osteobiographical Estimates: This table reflects the osteobiographical elements of age and sex, as determined throughout this study. With this knowledge, Bogin's (2012) life history stages have been assigned to each individual based on their estimated age. This data is presented according to ascending chronological age. This table should be interpreted as follows: 'I' represents 'Indeterminate', 'M' represents 'Male', 'PM' represents 'Probable Male', 'F' represents 'Female' and 'PF' represents 'Probable Female'.

IMPACT ID	Name	Period	~ Age (years)	Bogin's Life History Stage	Sex Estimation
IMP00004	Infant # 1 910.267.1	Unknown	< 1	Infancy	M
IMP00118	Unnamed	Roman Period	1 - 2	Infancy	M
IMP00022	Little Girl from Thebes	Roman Period	2 - 4	Infancy / Childhood	F
IMP00110	Keref	Late Period	3 - 6	Childhood	I / Suggested Male
IMP00115	Unnamed	Ptolemaic Period	3 - 6	Childhood	I
IMP00116	Unnamed	Ptolemaic Period	3 - 6	Childhood	M
IMP00064	Liverpool Mummy 7 (13.10.11.25)	Roman Period	3 - 6	Childhood	I / Suggested Male
IMP00031	Nesmut (ROM 910.268.1)	Third Intermediate	6 - 8	Late Childhood / Early Juvenile	F
IMP00033	Brussels Mummy E.00452	Ptolemaic Period	6 - 8	Late Childhood / Early Juvenile	I
IMP00056	Brussels Mummy E.09016	Late Period	8 - 10	Juvenile	M
IMP00055	Unnamed	Unknown	8 - 10	Juvenile	M
IMP00124	Marischal Museum mummy (ABDUA: 22116)	Ptolemaic Period	< 10	Childhood - Juvenile	I / Suggested Female
IMP00030	Unnamed	Unknown	< 10	Childhood - Juvenile	F
IMP00114	Unnamed	Unknown	< 10	Childhood - Juvenile	I
IMP00021	Fleming Mummy	Third Intermediate	12 - 15	Adolescence	PF
IMP00069	Nesshutefnut	Ptolemaic Period	14 - 18	Adolescence	I / Suggested Male
IMP00090	Mehit-em-Wesekht	Ptolemaic Period	14 - 18	Adolescence	F
IMP00117	Tasherytdjedhor / Sensaos	Roman Period	14 - 18	Adolescence	PF
IMP00059	Unnamed	Third Intermediate	15 - 21	Adolescence - Adulthood	F
IMP00122	Herakleides	Roman Period	18 - 21	Adolescence - Adulthood	PM
IMP00082	Baka / Bahka / Bahkah	New Kingdom	> 18	Adolescence - Adulthood	F

4.4 SUBADULT MORTUARY TREATMENT ACROSS TIME

With the examination of age and sex completed, the analysis shifted to the mortuary treatment of each individual. This subsection presents the results of an inquiry regarding the mummification styles and body positioning seen in the subadults examined in this work. Both of these analyses are presented using a temporal lens, as trends were observable across time.

4.4.1 SUBADULT MUMMIFICATION ACROSS TIME

As seen in Table 4.6 below, there appears to be some degree of correlation between time period and the observed mummification styles within the subadult population. Notably, 100% of the observable individuals dated to the Ptolemaic period were excerebrated, with the remaining two individuals from this period being indeterminable in regard to excerebration. This is notable as only two other individuals (12.5%) in this study were found to be excerebrated. Additionally, 100% of the observable mummies dated to the Roman period were confirmed to have been eviscerated, with the one remaining individual within this period scoring as indeterminate. This is significant given that only three of the other individuals included in this study (20%) were determined to have been eviscerated. Perhaps equally notable is the absence of trends seen between the age and/or sex of the individuals and the mummification styles. There are no discernable patterns associated with age or sex across any of the time periods or mummification styles. Given the small sample size, determining the significance of trends, or a lack thereof, is difficult. These patterns should be noted however, while the implications of this small sample will be explored further in the subsequent chapter.

Table 4.6 – Mummification & Temporal Period: This table reflects the mummification style of each of the individuals within this study. The data has been sorted chronologically. Note that the information should be interpreted as follows: N = No, Y = Yes, I = Indeterminate. This table should also be interpreted as follows: 'I' represents 'Indeterminate', 'M' represents 'Male', 'PM' represents 'Probable Male', 'F' represents 'Female' and 'PF' represents 'Probable Female'.

IMPACT ID	Date	Period	Cribriform Plate	Excer-brated	Cranial Resin	Evisce r-ated	~ Age (years)	Sex Estimation
IMP00082	1300 BC	New Kingdom	I	N	N	Y	> 18	F
IMP00059	943 - 715 BC	Third Intermediate	I	I	I	Y	15 - 21	F
IMP00031	940 – 720 BC	Third Intermediate	Unbroken	N	N	I	6 - 8	F
IMP00021	746 - 653 BC	Third Intermediate	Broken	Y	N	I	12 - 15	PF
IMP00056	747 - 525 BC	Late	I	I	N	I	8 - 10	M
IMP00110	664 - 525 BC	Late	Broken	Y	N	I	3 - 6	I / Suggested Male
IMP00033	400 - 101 BC	Ptolemaic	I	I	N	I	6 - 8	I
IMP00069	332 BC	Ptolemaic	I	I	I	I	14 - 18	I / Suggested Male
IMP00124	332 - 30 BC	Ptolemaic	I	Y	Y	Y	< 10	I / Suggested Female
IMP00115	304 - 318 BC	Ptolemaic	I	Y	N	I	3 - 6	I
IMP00116	304 - 318 BC	Ptolemaic	I	Y	N	N	3 - 6	M
IMP00090	300 BC	Ptolemaic	Broken	Y	N	I	14 - 18	F
IMP00118	30 BC - 640 AD	Roman	Broken	Y	N	Y	1 - 2	M
IMP00122	30 BC - 640 AD	Roman	Unbroken	N	N	Y	18 - 21	PM
IMP00117	109 AD	Roman	Broken	Y	N	Y	14 - 18	PF
IMP00064	100 - 150 AD	Roman	I	I	I	I	3 - 6	I / Suggested Male
IMP00022	220 – 270 AD	Roman	I	I	N	Y	2 - 4	F
IMP00004	Unknown	Infant # 1 910.267.1	I	I	N	N	< 1	M
IMP00055	Unknown	Unknown	I	I	I	I	8 - 10	M
IMP00030	Unknown	Unknown	I	I	N	I	< 10	F
IMP00114	Unknown	Unknown	I	I	I	I	< 10	I

The analysis of the head and limb positioning is presented in Table 4.7. Although there were again no sex or age related trends seen across this data, there were two observable temporally defined patterns. Notably, four of the six individuals (66.7%) within the Ptolemaic period were mummified with their upper limbs in a flexed position across their chest (Figure 4.2). Additionally, 100% of the individuals under the age of 18 years of age, whose head positioning could be observed, exhibited the forced 'chin-down'

position (Figure 4.3). These findings will be compared closely with Davey's many publications (e.g. Davey, Craig & Drummer, 2014) surrounding this positioning in the following chapter. Only the eldest individual (18 – 21 years of age) within this period (IMP00122) definitively did not present with this purposeful head positioning. It should be stated that the other Roman individual (IMP00022) had a head positioning that was indeterminable, given extensive damage that had occurred to her skull.

Figure 4.2: An X-ray image of IMP00069, illustrating the appearance of flexed upper limbs. The radius and ulna are clearly visible crossing the body (Graves, 2020).

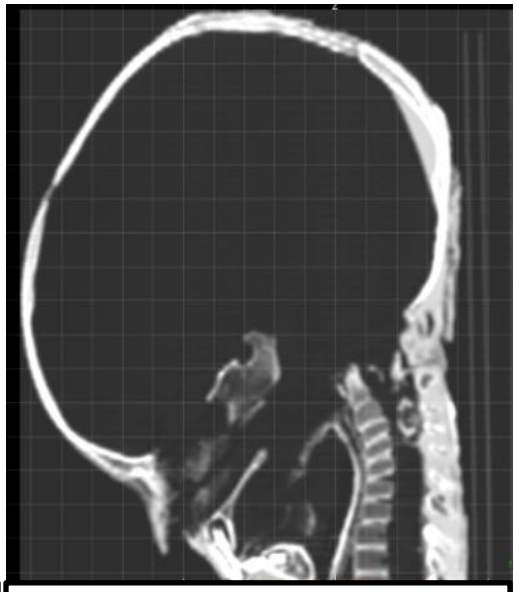

Figure 4.3: A lateral X-ray of IMP00118 illustrating the forced 'head-down' position referred to throughout this work (Graves, 2020).

Table 4.7 – Time Period & Body Positioning: This table addresses the position of the head, upper limb, and lower limb of each individual and has been sorted chronologically, according to the period within which each person is associated.

IMPACT ID	Date	Period	Head	Upper Limb	Lower Limb
IMP00082	1300 BC	New Kingdom	Head leaning posteriorly, mouth closed.	Bilaterally extended, palms on anterior thigh.	Bilaterally extended, toes pointed upward.
IMP00059	943 - 715 BC	Third Intermediate	Head leaning posteriorly, mouth closed.	Bilaterally extended, palms on lateral thigh.	Bilaterally extended, toes pointed upward.
IMP00031	940 – 720 BC	Third Intermediate	Indeterminate due to shifting during unwrapping.	Bilaterally extended, palms on lateral thigh.	Bilaterally extended, toes pointed upward.
IMP00021	746 BC - 653 BC	Third Intermediate	Head leaning posteriorly jaw disarticulated.	Bilaterally extended, palms on anterior thigh.	Indeterminate
IMP00056	747 - 525 BC	Late	Chin resting on chest, not forcibly placed, mouth closed.	Bilaterally flexed, arms crossed over chest.	Bilaterally extended, toes pointed upward.

IMP00110	664 - 525 BC	Late	Head leaning posteriorly, mouth closed.	Bilaterally extended, palms on top of pelvic area.	Bilaterally extended, toes pointed upward.
IMP00033	400 - 101 BC	Ptolemaic	Head leaning laterally, mouth open.	Bilaterally extended, palms on top of pelvic area.	Bilaterally extended, toes pointed upward.
IMP00069	332 BC	Ptolemaic	Head leaning posteriorly, mouth open.	Bilaterally flexed, arms crossed over chest.	Bilaterally extended, feet broken, possibly for shortening at ankle, and turned medially.
IMP00124	332 - 30 BC	Ptolemaic	Chin resting on chest, not forcibly placed, mouth closed.	Bilaterally flexed, arms crossed over chest.	Bilaterally extended, toes pointed upward.
IMP00115	304 - 318 BC	Ptolemaic	Head leaning posteriorly mouth closed.	Bilaterally flexed, arms crossed over chest.	Bilaterally extended, toes pointed upward.
IMP00116	304 - 318 BC	Ptolemaic	Chin resting on chest, not forcibly placed, mouth closed.	Bilaterally extended, palms on lateral thigh.	Bilaterally extended, toes pointed upward.
IMP00090	300 BC	Ptolemaic	Head leaning posteriorly, mouth open.	Bilaterally flexed, arms crossed over chest.	Bilaterally extended, toes pointed upward.
IMP00118	30 BC - 640 AD	Roman	Chin down in a forced manner, fracturing of vertebrae, mouth closed.	Bilaterally extended, palms on lateral thigh.	Bilaterally extended, toes pointed upward.
IMP00122	30 BC - 640 AD	Roman	Head leaning posteriorly, mouth slightly open.	Bilaterally extended, palms on top of pelvic area.	Bilaterally extended, toes pointed upward.
IMP00117	109 AD	Roman	Chin down in a forced manner, fracturing of vertebrae, mouth closed.	Bilaterally extended, palms on lateral thigh.	Bilaterally extended, toes pointed upward.
IMP00064	100 - 150 AD	Roman	Chin down in a forced manner, fracturing of vertebrae, mouth closed.	Bilaterally extended, palms on anterior thigh.	Bilaterally extended, toes pointed upward.
IMP00022	220 – 270 AD	Roman	Indeterminate due to extensive damage.	Bilaterally extended, palms on lateral thigh.	Bilaterally extended, toes pointed upward.
IMP00004	Unknown	Unknown	Chin to chest, cannot determine if this was forceful due to high amounts of shifting and fracturing. Wooden stake inserted from thorax into the base of skull.	(L)Extended palm on anterior thigh / (R) Extended palm on lateral thigh.	Bilaterally extended, both feet turned to left hand side.
IMP00055	Unknown	Unknown	Head leaning posteriorly jaw disarticulated.	Bilaterally flexed, arms crossed over chest.	Bilaterally extended, feet not included.
IMP00030	Unknown	Unknown	Chin down in a forced manner, fracturing of vertebrae, mouth closed.	Bilaterally extended, palms on lateral thigh.	Bilaterally extended, toes pointed upward.
IMP00114	Unknown	Unknown	Skull not included in X-ray.	Bilaterally extended, palms on anterior thigh.	Bilaterally extended, toes pointed upward.

4.4.2 MISCELLANEOUS MUMMIFICATION OBSERVATIONS

Additional variables including hair presence and associated items found within the wrappings or body cavities of the deceased were documented for this thesis. Although these findings were less significant than those mentioned above, they remain relevant to this study and are therefore presented in Table 4.8 below. There are no observable trends seen in either hair presence or grave goods across time in this sample population. Pathological lesions were also recorded, however due to the highly fragmented state of the majority of the remains, these results were inconclusive and have therefore been removed.

Table 4.8 – Associated Items & Hair Presence Across Time: This table presents the limited findings of associated items and hair presence associated with each individual within the study population. The modality 'FH' is indicative of First Hand analysis. These results have been sorted according to chronological order.

IMPACT ID	Modality	Date	Period	Hair	Associated Items with Remains
IMP00082	CT	1300 BC	New Kingdom	Long tufts across top of skull.	None
IMP00059	X-ray	943 - 715 BC	Third Intermediate	Short tufts across top of skull.	None
IMP00031	FH	940 – 720 BC	Third Intermediate	Brown fragments up to 10 cm long.	Indeterminate
IMP00021	CT	746 - 653 BC	Third Intermediate	None	None
IMP00056	X-ray	747 - 525 BC	Late	None	None
IMP00110	CT	664 - 525 BC	Late	None	None
IMP00033	X-ray	400 - 101 BC	Ptolemaic	None	None
IMP00069	X-ray	332 BC	Ptolemaic	None	Ring present on the third or fourth finger of the left hand.
IMP00124	X-ray	332 - 30 BC	Ptolemaic	None	Papyrus scroll placed within thoracic cavity along with three other abdominal packages.
IMP00115	CT	304 - 318 BC	Ptolemaic	None	None
IMP00116	CT	304 - 318 BC	Ptolemaic	None	None
IMP00090	X-ray	300 BC	Ptolemaic	None	None
IMP00118	CT	30 BC - 640 AD	Roman	None	None
IMP00122	CT	30 BC - 640 AD	Roman	Short tufts across top of skull.	None
IMP00117	CT	109 AD	Roman	Short tufts of hair across top of skull.	None
IMP00064	X-ray	100 - 150 AD	Roman	None	Amulet in mouth and around genital area, likely metallic.
IMP00022	CT	220 – 270 AD	Roman	None	None
IMP00004	CT	Unknown	Unknown	None	None
IMP00055	X-ray	Unknown	Unknown	None	None
IMP00030	X-ray	Unknown	Unknown	None	None
IMP00114	X-ray	Unknown	Unknown	None	None

4.5 PROVENIENCE ELABORATION & MISCELLANEOUS OBSERVATIONS

Throughout this study miscellaneous findings, including provenience information and wrapping style/materials were also observed. Although these results do not present many noteworthy temporal trends, or trends in general, they do provide valuable contextual data and are therefore included in Table 4.9 below. Although the significance of this finding is difficult to determine, it may be notable that amongst the 21 individuals within this sample there are a supposed Princess (IMP00082), two Chantresses (IMP00031, IMP00059), and a Priest's daughter (IMP00090) as noted by the inscriptions on each associated coffin. Perhaps these results are coincidental, or perhaps they speak to the importance of status or piety within Ancient Egypt, which will be addressed further in the subsequent chapter of this work. This table provides some geographical provenience, however it has proven extremely difficult to obtain accurate locations from which these mummies originated. This is likely due to the lengthy duration of time that has passed since their procurement, as well as the shuffling that would have occurred during the mummy trade of the 19th and early 20th century.

Table 4.9 – Additional Findings According to Time Period: This table presents all of the miscellaneous findings documented throughout the study, which includes wrapping styles and any additional known provenience that could be documented on each individual. The information is sorted in chronological order.

IMPACT ID	Name	Period	Additional Findings	~ Age (years)	Sex Estimate
IMP00082	Baka / Bahka / Bahkah	New Kingdom	Thought to be a Princess from Thebes, elaborately decorated wooden coffin with linen wrappings.	> 18	F
IMP00059	Liverpool Mummy 2 (M13997a)	Third Intermediate	Associated with the coffin of a Chantress belonging to the Temple of Amun, external bandages were discoloured but painted eyes and mouth were visible, each digit bound separately, feet wrapped in imitation sandals.	15 - 21	F
IMP00031	Nesmut (ROM 910.268.1)	Third Intermediate	Elaborately decorated coffin with inscription 'Lady of the House; Chantress of Amun-Re'.	6 - 8	F
IMP00021	Fleming Mummy	Third Intermediate	Highly fragmented remains, lower limbs excluded from scan.	12 - 15	PF
IMP00056	Brussels Mummy E.09016	Late	Accompanying coffin is bearded (male), elaborately decorated, metal wiring found within body of mummy, possibly for articulation.	8 - 10	M
IMP00110	Keref	Late	Elaborately painted bearded coffin (male), linen wrappings with feet wrapped separately.	3 - 6	I / Suggested Male
IMP00033	Brussels Mummy E.00452	Ptolemaic	Discovered in Al-Fayyum, linen wrappings in a crossover pattern with a painted faceplate.	6 - 8	I

IMP00069	Nesshutefnut	Ptolemaic	Liverpool Mummy 12 (13.12.05.34a), said to be male, gilded mask and linen wrappings coated with black resin.	14 - 18	I / Suggested Male
IMP00124	Marischal Museum mummy (ABDUA: 22116)	Ptolemaic	Brown hempen swathings, one side coated in starch of rye, cartonnage of plaster and linen elaborately painted, said to be female.	< 10	I / Suggested Female
IMP00115	Unnamed	Ptolemaic	Plaster coating on remains made analysis difficult due to the inability to separate it from bone, making long bone measurements impossible.	3 - 6	I
IMP00116	Unnamed	Ptolemaic	Plaster coating on remains made analysis difficult due to the inability to separate it from bone, making long bone measurements impossible.	3 - 6	M
IMP00090	Mehit-em-Wesekht	Ptolemaic	Accompanying coffin elaborately decorated, thought to be the daughter of a priest at the Temple Min at Akhmim, coffin painted with faceplate, mummy wrapped in linen.	14 - 18	F
IMP00118	Unnamed	Roman	Plaster coating on remains made analysis difficult due to the inability to separate it from bone, making long bone measurements nearly impossible.	1 - 2	M
IMP00122	Herakleides	Roman	Elaborately adorned wrappings made of linen, faceplate of a young male accompanying remains.	18 - 21	PM
IMP00117	Tasherytdjedhor / Sensaos	Roman	Neither femur is fully visible within scans and epiphyses are fractured, leading to diaphyseal measurements only.	14 - 18	PF
IMP00064	Liverpool Mummy 7 (13.10.11.25)	Roman	Decorative wrappings with painted panel portrait, 13 layers of diagonal wrappings, CT scan completed, said to be male.	3 - 6	I / Suggested Male
IMP00022	Little Girl from Thebes	Roman	Accompanying elaborately painted coffin of a woman. Extremely fragmented skull with potential Harris Lines visible on long bones.	2 - 4	F
IMP00004	Infant # 1 910.267.1	Unknown	Metopic suture remains unfused, wrappings are made of linen.	< 1	M
IMP00055	Unnamed	Unknown	None	8 - 10	M
IMP00030	Unnamed	Unknown	None	< 10	F
IMP00114	Unnamed	Unknown	Partial remains only, assemblage includes both subadult and adult remains, only subadult remains scored.	< 10	I

In the following chapter of this work, these results will be explored further and discussed within their broader context. The research questions that were posed at the beginning of this thesis will be revisited, answered, and reflected upon in great detail according to the findings presented above. Finally, the limitations of this study, which have been discovered throughout this analysis will be documented and explained. With these limitations in mind, the future works that may be conducted to explore the concept of Ancient Egyptian subadulthood in greater detail will also be addressed.

CHAPTER 5

DISCUSSION: LIFE HISTORY STAGES IN ANCIENT EGYPT

This chapter explores the interpretations and implications of the results presented in the previous chapter. These findings will be explored specifically in terms of their relevance to the focal questions of this thesis, which were presented in Chapter One. Additional information surrounding previously published literature will be presented for comparative purposes. Emphasis will be placed on the similarities and/or differences that exist between the mortuary treatment of this study's subadults and known adults of similar temporal periods. This chapter aims to provide the reader with a better understanding of the significance of the results presented here, and this thesis in its entirety, while also outlining directions for future research.

5.1 SEQUENTIAL LIFE STAGES IN ANCIENT EGYPT

The sample population within this study includes individuals from all of Bogin's (2012) life history stages except the 'Late Life Stage', which occurs after 'Adulthood'. This fact alone supports the premise that life was viewed as valuable in Ancient Egypt throughout each life stage, given the effort that was evidently required to mummify an individual. This will become more apparent during a subsequent section of this work, which discusses a subsample of known mummified Ancient Egyptian fetuses. Although the scope of this study population is admittedly not all encompassing, due to the small sample size, the patterns or lack thereof seen within the data are nonetheless meaningful.

Upon analyzing the results and attributing the etic life history stage to each focal individual, following Bogin (2012), there do not appear to be any significant trends that are indicative of differential mortuary treatment across life history stages (Table 4.5; Table 4.6). To explain further, the mummification styles do not appear to differ between life history stages any more that than they do within each life history stage. Therefore, it should be noted that there are no discernable patterns to be reported in terms of the relationship between mummification style (excerebration, evisceration, resin presence) and Bogin's (2012) life history stages within this sample population. This finding suggests that perhaps age was not the most significant variable in terms of dictating how a subadult was treated posthumously, particularly in regard to their mummification style. This is not to say however that there are no patterns within the data that was gathered, but

rather these patterns appear to be more closely linked to other variables including temporal period and sex (Vandenbeusch & Antoine, 2020).

As seen in Table 4.1, there is one evident sex linked trend that appears in relation to the age at death of the individuals. Although age in itself did not present any compelling patterns, when age and sex were combined, a visible trend arises. Consider that the average age at death of male mummies included in this study (n = 9) was 7.7 years, calculated as outlined in section 4.1. This is in comparison to the average age at death of females in this study (n = 9), which was 12.4 years, calculated in the same manner. This presents an average age differential of 4.7 years between males and females of this study population. Notably the youngest identified confirmed female mummy known to the author, save the fetuses detailed later, is the Little Girl from Thebes, who died between ages of two and four years. Note that of the seven mummies less than five years of age, three are male, two are suggested males, one is indeterminate and only one is female (Table 4.1).

This observation is consistent across most other studies, including Davey's (see Section 5.5), as her examinations have included a narrow sample of females (n = 2), each of which were amongst the oldest of her focal individuals. It is this observation that allows for the formation of the hypothesis that females may have generally obtained full personhood, worthy of mummification, at a later age than their male counterparts. Consider the fact that of the known 75 subadult Ancient Egyptian mummies gathered from the literature and detailed in Appendix B.1 the youngest female individual is five years of age. This is in comparison to the youngest male, who is < 1 year of age, further contributing to the validity of this trend by greatly expanding the sample size of this work. This is a hypothesis that is compelling, worthy of additional consideration throughout this chapter, and further research in the future (see Section 5.5 for consideration of relevant published data). This may also illustrate a life history stage transition from the Childhood stage into the Juvenile stage in females, with the various physical and social factors this shift reflects. Notably, this hypothesis contrasts with Meskell's (2000) hypothesis that females may have matured through life stages at an earlier age than males. Although physically this may have been the case, with females

progressing through puberty before males, their social recognition of personhood appears to have occurred in the inverse order, according to the findings of this thesis.

There is one known female (IMP00022), commonly referred to as the "Little Girl from Thebes", who is estimated to have been between the ages of two and four years (Conlogue et al., 2021:56). Very little is known about her beyond the fact that she originated from Dier el Bahari and is included in this study and is housed at Yale's Peabody Museum in New Haven, Connecticut, the same institution she was first catalogued at in 1919 (Conlogue et al., 2021:54). Analysis determined that she was in fact female based on her external genitalia. Although this example may seem to take away the credibility of the previously mentioned hypothesis, this claim is made as a general observation, rather than a concrete rule, which points to the fact that the "Little Girl from Thebes" was exceptional. This suggests that perhaps personhood was ascribed more readily in males than in females, as the number of known Ancient Egyptian females under the age of five years is only one out of 96.

In terms of the physical treatment and mummification of the individuals, there do not appear to be any discernable differences related solely to the sex of the deceased (Table 4.6). Understanding whether a pattern between age and sex exists in mummified Ancient Egyptian subadults could certainly be an area of future study and exploration. As sex based differences continue to be a topic of modern discussion, gathering a better understanding of how these differences were or were not acknowledged in life, and in this case in death, within ancient civilizations would surely be valuable. The relationship between sex, status and mummification style may also be an interesting topic seeing as resin, thought to be indicative of high status individuals (Wade & Nelson, 2013), was only found in one mummy included in this study.

5.2 GEOGRAPHICAL & TEMPORAL INFLUENCES ON POSTMORTEM TREATMENT

First, it should be explicitly stated that it was not possible to determine if geographic influences impacted the individuals within this study population. Poor documentation of provenience made it impossible to accurately evaluate if the location in which each individual lived and/or died was significant in relation to their postmortem treatment. It is likely that the mummy trade, which was active throughout Egypt for

centuries, was a large contributor to the lack of provenience data available for these individuals (Daly, 1994). As mummies became desirable commodities for collectors, the removal of an individual from their coffin and relocation into another, more elaborately adorned one, which would of course be worth more money to the seller, was common practice, again further complicating the ability to trace where the deceased originated (Daly, 1994). For these reasons, this work does not attempt to make any claims in regard to geographic parameters.

Fortunately, distinguishing the temporal period in which an individual existed is less complicated than determining their place of origin. Due to a number of techniques including carbon dating, known use of materials, and many others, a date range in which an individual lives may often be determined (Aufderheide, 2003). The temporal period in which the mummies in this sample population existed was known and documented for 16 of the 21 individuals (76.2%). Although certainly this may be problematic in terms of interpretations based on associated coffins, which may not belong to the individual within them, these potential confounding variables have been negated to the best of the researchers' ability based on the compatibility of the individual with the physical coffin (e.g. age, sex, size, wrappings corroborating together). With this knowledge, it became evident that patterns were observable between temporal period and postmortem treatment (Table 4.6; Table 4.7).

When examining Table 4.6 a couple of patterns appear, which illustrate the potential for a relationship between subadult mummification style and temporal period. Consider that 100% of the individuals with observable internal structures in the Roman Period were eviscerated. These results are similar to those found in Wade and Nelson's 2013 publication, which illustrated that six out of seven (85.7%) Roman Period adult mummies had been eviscerated, further supporting this trend in adults of the same temporal period. Additionally, it is notable that 100% of the individuals in the Ptolemaic Period with assessable excerebration were in fact excerebrated. The significance of this trend remains more difficult to discern as only two of the three (66.7%) of the strictly Ptolemaic Period individuals were excerebrated in Wade and Nelson's 2013 study. What should be taken away from these findings is that excerebration and evisceration were

variable throughout time, therefore in order to substantiate such claims a larger sample population for comparative purposes will be required.

Additionally, the limb positioning of subadults postmortem appears to differ across time periods, presenting interesting trends (Table 4.7). Consider that four of the six (66.7%) individuals in the Ptolemaic Period have their upper limbs in a flexed position, a position that was often associated with Royal mummies of the New Kingdom. This trend becomes increasingly compelling as only two other individuals in the entire sample were observed to have flexed upper limbs, one of which was from an unknown time period. This means that of the 30% of mummies with flexed upper limbs in this sample, 66.7% were from the Ptolemaic period, which makes this finding more significant than it may have appeared previously.

It was suggested by Gray's 1972 study that consistent changes in adult upper limb positioning could be observed across temporal periods. Certainly there is evidence to support this claim in subadults, as seen in section 5.2. Further comparisons were made to evaluate the significance of the flexed upper limbs in the Ptolemaic Period, which were observed in 66.7% of the mummified subadults. In a 2015 study, Tennant reports that "a much higher proportion than expected [of Ptolemaic mummies within this study] ha[d] their hands in the crossed pectoral position (n=11 of 15; 73.3%)" (Tennant, 2015: 55). To clarify, what Tennant refers to as the 'crossed pectoral position' is synonymous with what this work labels 'bilaterally flexed, arms crossed over chest'.

It is notable that these findings seem to support a common finding, which is reinforced in Gray's 1972 work. These results suggest that temporal body positioning trends, although variable, existed in Ancient Egypt mummification and were not age dependent, as adults and subadults exhibited the same patterns (Loynes, 2015). Further support for this conclusion may be obtained by referring to Power's 2011 study in which she examined Egyptian skeletons from the Early Dynastic to Middle Kingdom periods. Her findings state that the burials of subadults "conformed to the same position and orientation trends as observed for contemporary adult interments" (Power, 2011: 94).

The final pattern that was discernable between body positioning and temporal period is a familiar one that was addressed in the earlier chapters of this work. It may be observed that 100% of the individuals in the Roman Period under the age of 18 years

were observed to have their head in a chin-down, or as Davey calls it 'head-down' position. As mentioned previously, this involves the purposeful and deliberate forcing of the mandible toward the sternum to the point that fracturing of the vertebrae is often visible (Figures 2.1 & 4.3). This finding is certainly notable as Davey explains that in her experience this 'head-down' position is seen in "all Graeco/Roman child mummies that have been studied by the authors to date. The reason for this is unknown and appears to be particular to the Graeco/Roman Period" (Craig & Davey, 2009:20). Evidently then, in this study and previous ones, there have been trends observed between the body positioning of subadult mummies and temporal periods, which this study further supports. However, this study corroborates Davey's results only in terms of the Roman Period. None of the Graeco Period (referred to here as the Ptolemaic Period) individuals in this thesis were found to have this head positioning, and so these findings cannot be confirmed. As a result of this finding, none of the conclusions surrounding this head-down position extend beyond the Roman Period in the remainder of this work.

5.3 SUBADULT STATUS & SEX

The individuals within this study are likely all of elevated social status as mummification was time consuming, expensive and deliberate in Ancient Egypt. Therefore, this would not have been done for all individuals, whether adult or subadults. The alternatives to mummification that existed at the time have been detailed in multiple other studies and often involved the burial of skeletal remains in cemeteries (e.g. Power, 2011). With that said, are there are additional indicators of status that were incorporated into the mummification process itself. Consider that the only individual who was observed to have resin present within their cranium, which is thought to be a status associated practice (Wade & Nelson, 2013), was the Marischal Museum Mummy (IMP00124), a suggested female mummy less than ten years of age from the Ptolemaic Period (Table 4.6). Although the cartonnage she was associated with was elaborately painted (Table 4.6), very little is known about her status in life and/or in death (Table 4.9). What is perhaps notable, and will be discussed further in the Appendix of this work, is that four of the individuals in this study were said to be either Princesses, Chantresses, or daughters of Priests. IMP00082, who is commonly referred to as Baka, Bahka or Bahkah, was thought to be a Princess from Thebes. She was associated with an

elaborately decorated wooden coffin and linen wrappings (Table 4.9). She is located at the Museum of World Treasures in Kansas City (Table 3.2).

IMP00059 and IMP00031, Liverpool Mummy 2 and Nesmut respectively, are both thought to be Chantresses belonging to the Temple Amun and originating in the Third Intermediate Period (Table 4.9). IMP00059, Liverpool Mummy 2 was wrapped in external bandages showing painted eyes and a painted mouth with each digit bound separately and her feet bound in imitation sandals. The preparation, time and effort that would have gone into this mummification should certainly be recognized. IMP00090, known as Mehit-em-Wesekht who is located at the Museum of New Zealand, is thought to be the Princess daughter of a Priest at the Temple Min at Akhmim. She was again associated with an elaborately adorned coffin including a faceplate and linen wrappings (Table 4.9). Each of these individuals was mummified with great care and consideration for both their role in life and preservation in the afterlife.

Evidently a Princess would be considered to be an individual of high status due to the title she held in life (Onstine, 2001). Interestingly, a similar sentiment can be applied to Chantresses as the "community of elite officials and wealthy members of the middle class were usually involved in the dominant state religious institutions" (Onstine, 2001:96). This suggests that although Chantresses may not have been considered as elite as Princesses, they were certainly not of poor status. Given the high wealth that was generally attributed to religious officials,

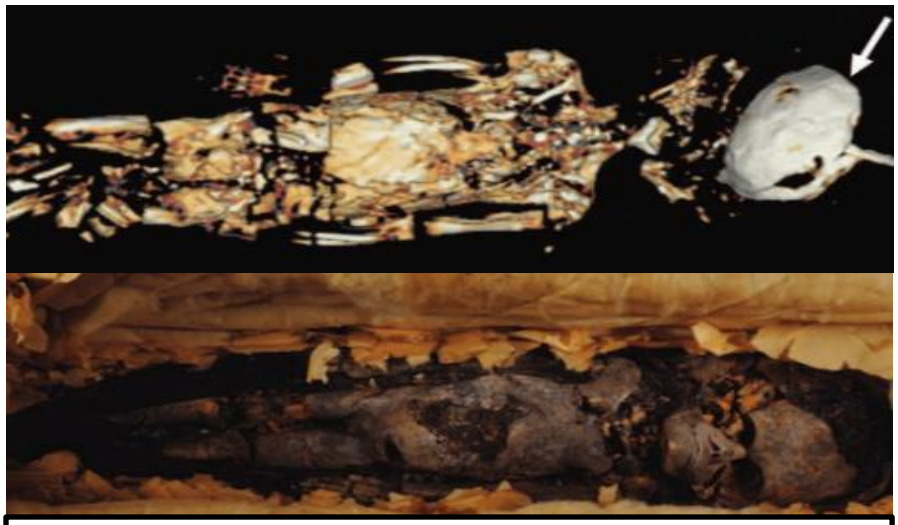

Figure 5.1 – King Tutankhamun's two mummified fetal daughters. The daughter on the bottom is seven to nine months gestation. The daughter on the top, who is displayed using a CT scan, is five to seven months gestation (Hawass & Saleem, 2011: W831 – W832).

the assumption may be made that the Priest's daughter would also have held a fairly elevated status.

As these four individuals make up 44.4% of the female mummies included in this study the potential connection between status and sex should be mentioned. Perhaps this again points toward the fact that female personhood was something to be earned throughout one's life, with some exceptions (e.g. 'Little Girl from Thebes'), further supporting the hypothesis presented earlier, whereas male status may have been more easily attainable or more often ascribed. Perhaps being of elevated status made personhood more attainable for these females, or perhaps it is this status that played a role in the ascription of their personhood leading to their mummification. The concept of personhood is something that is both fascinating and relevant to Ancient Egyptian mortuary studies, particularly in terms of the social implications that it illustrates, especially when one considers the known samples of mummified fetuses.

5.4 ANCIENT EGYPTIAN MUMMIFIED FETUSES

To date, to the best of this study's knowledge, there are nine known mummified fetuses in existence (Table 5.1), with one potential caveat to be discussed. Although fetuses are plentiful within the archaeological record (Power, 2011), mummified fetuses are exceptionally rare (Nelson et al., 2018).

Table 5.1 – Summary of Known Ancient Egyptian Fetuses: This table illustrates each of the nine known mummified Ancient Egyptian fetuses and summarizes the information known about each. This table should be interpreted as follows: 'I' represents 'Indeterminate', 'M' represents 'Male', 'F' represents 'Female'. These findings were reproduced from Nelson et al., 2018.

Mummified Fetus	~ Gestational Age	Period	Position	Sex	Anencephalic
Kellis II	15 weeks	Roman	I	I	No
British Museum	I	Roman	I	I	No
Maidstone Museum	23 – 28 weeks	Ptolemaic	Arms Flexed	M	Yes
Fitzwilliam Museum	18 weeks	Late	Arms Flexed	I	No
Tuna el-Gebel	I	Ptolemaic	Seated, Arms/Legs Flexed	I	Yes
Swansea University	12 – 16 weeks	Late	I	I	No
King Tut 1	20 – 28 weeks	New Kingdom	Arms Extended	F	No
King Tut 2	28 - 36 weeks	New Kingdom	Arms Extended	F	No
Lortet & Gaillard	I	I	Arms Flexed	I	Possible

Perhaps the most famous of these fetuses are King Tutankhamun's (Tut) two daughters (Figure 5.1) who died at the gestational ages of five to seven and seven to nine months (Hawass & Saleem, 2011). This age estimate was the result of an initial autopsy done by Douglas Derry in 1932, in combination with the 2011 Hawass & Saleem CT study. As the only two confirmed female mummified fetuses in Ancient Egypt, and likely the youngest mummified female individuals, their status in relation to personhood must be considered. As the daughters of King Tutankhamun, it could be argued that these individuals were born 'persons' by virtue of being the daughters of the Pharaoh. This would thereby not negate the hypothesis mentioned throughout this chapter (females may have generally obtained full personhood, worthy of mummification, at a later age than their male counterparts), but rather enriches it. Consider that this information may allow for the expanded hypothesis that, in the absence of ascribed royal status differentials, males have personhood, and are therefore mummified from birth on, whereas non-royal females do not usually achieve it until the age of about five years. Again, future research into this hypothesis is required in order to either confirm it, refute it, or build upon it.

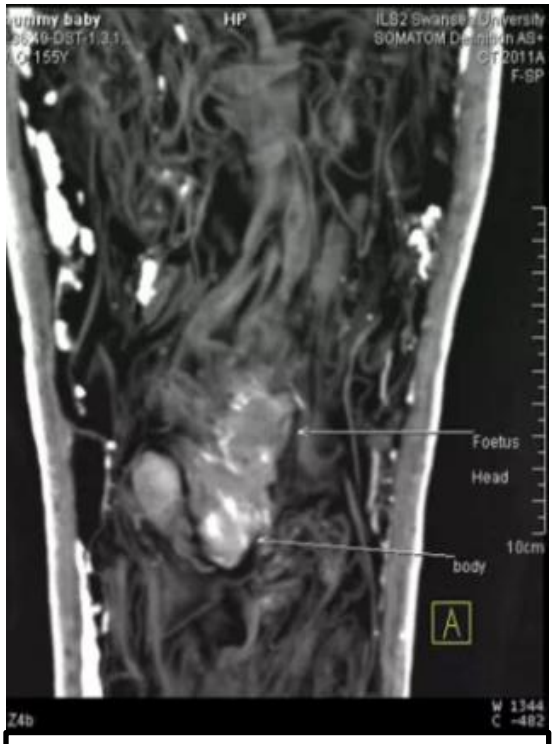

Figure 5.2 – the Swansea mummy, the youngest known mummified fetus can be seen within the grossly oversized cartonnage in which they rest. (Lorenzi, 2014: 1).

These individuals were found within King Tut's tomb as "in Ancient Egypt still born infants and fetuses were [often] buried with their parents" (Hawass & Saleem: W832). These two girls, the youngest mummified females known, would have been born into the New Kingdom, much like Bahkah (IMP00082) from this sample population. What is perhaps noteworthy is that both of these fetuses were found to have their arms in an extended position with their hands beside or on top of their thighs (Hawass & Saleem, 2011). Similarly, Bahkah's upper limbs were in an extended position with her palms

placed on the anterior aspect of her thighs. This is in contrast to the fact that adult royals in the New Kingdom tended to have their arms in a flexed position (Tennant, 2015). This may hint at a stylistic mummification choice for the New Kingdom in terms of limb positioning.

Two additional fetuses have been dated to the Roman Period, one of which was found at the Kellis II site in the Dakhleh Oasis (Frankfurter, 2006: 43). This individual was discovered in 1993 and was estimated to be 14 weeks gestation after being found within the roof of a fourth century house (Frankfurter, 2006: 43). The other Roman Period fetus is in the collection of the British Museum and unfortunately cannot be given a gestational age estimate due to poor preservation (Dawson & Gray, 1968). This particular fetus has extremely well preserved wrappings indicative of mummification, however all that remains within the wrappings is a few disarticulated bones, leading some to argue that this individual may not have been mummified to begin with, which would further narrowing the sample size to only eight (Dawson & Gray, 1968).

The Fitzwilliam Museum fetus, of 16 - 18 weeks gestation, has been dated to the Late Period (Table 5.1). Although the bones of the skull and upper limbs appear to be highly fragmented, it remains possible to observe that the individuals' arms were crossed over their chest (Geggle, 2016). This upper limb positioning is consistent with one of the two Late Period individuals included within this study (Table 4.7). A fetus of similar gestation, just 12 to 16 weeks, is housed at Swansea University (Lorenzi, 2014). This individual, who is the youngest known mummy, also dates to the Late Period (Table 5.1). Interestingly this fetus is held within a cartonnage that is 20 inches in length,

Figure 5.3: An anencephalic fetus, illustrating malformation of the cranium and visible brain tissue remaining (Gole, Meshram & Hattangdi, 2014:AC08).

meaning the remains take up only a fraction of the space within (Figure 5.2) (Lorenzi, 2014).

What is perhaps one of the most fascinating things about mummified Ancient Egyptian fetuses is that within the sample size of nine (including the skeletonized individual at the Roman Museum), the three that have not yet been mentioned all appear to share a common trait: anencephaly. With three (two of which are confirmed, one is speculative) of only nine (33%) individuals known across what is recognized as Ancient Egypt presenting with this condition, it is highly unlikely that this is coincidental. Anencephaly is a serious congenital defect of the neural tube "in which parts of the brain and skull are not developed... it is also associated with other malformations which are not related to neural tube development" (Gole, Meshram & Hattangdi, 2014: AC07). These malformations create an identifiable diagnostic appearance in the fetuses (Figure 5.3), which may have been revered in Ancient Egypt, given the prevalence of anencephalic fetuses. These features may also have been mistaken for those of various animals as the two confirmed anencephalic fetuses were associated with animal contexts (Geoffrey Saint-Hilaire, 1826; Dasen & Leori, 2017).

Although these claims remain largely speculative due to the small sample size this is another area of future research that would be compelling. Consider that a fetus of 23 – 28 gestational weeks is housed at the Maidstone Museum and has been confirmed to be an anencephalic male (testes were observable, allowing for sex determination) (Nelson et al., 2018). This particular individual was dated to the Late Ptolemaic Period and is observed as having their arms flexed across their chest (Figure 5.4). This is consistent with the four of six Ptolemaic subadults observed as having their upper limbs flexed within this sample population (Table 4.7). Notably this fetus was wrapped in a cartonnage with the head of a falcon and small human-like feet, perhaps as a result of the gross physical malformations of anencephaly

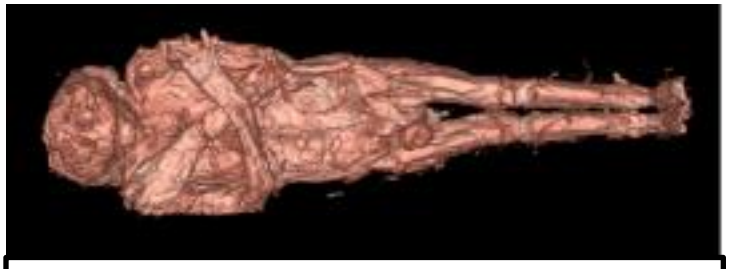

Figure 5.4: The Maidstone fetus, illustrated in with its arms flexed across its chest. Anencephalic features were confirmed using CT scans (pictured) (Nelson et al., 2018: 23).

and the misinterpretation of these as being animalistic. However, this is merely a hypothesis, which would require further exploration.

The other confirmed case of anencephaly in a mummified Ancient Egyptian fetus came from a gallery reserved for animals consecrated to the lunar god Thot, revered in the form of a baboon or ibis in Tuna el-Gebel (Dasen & Leori, 2017). This individual was first documented by Geoffrey Saint-Hilaire in 1826 and was further analyzed by Dasen and Leori in 2017. It is likely that due to the disfigurement that is characteristic of anencephaly, the individual was mistaken for, or closely associated with, a baboon (Nelson et al., 2018). This individual could not be assigned a temporal period but been given a gestational age of approximately seven months. This anencephalic fetus was mummified in a seated position with their lower limbs flexed, similar to the position in which baboons are often observed (Figure 5.5). The remains of this fetus are housed at the Egyptian Museum in Berlin. This individual in combination with the similarities seen in the Maidstone fetus suggest that anencephaly may have been viewed as a blessed condition associated with divine animal entities and reverence.

Finally, although it has yet to be confirmed, a third suggested anencephalic fetus has been documented. This suggestion was made on the basis of observable morphological features. This individual was initially thought to be a non-human primate, again showing similarity to the above-mentioned animalistic associations in anencephalic fetuses. Although it has not been confirmed whether the individual was in fact anencephalic they do appear to have similar morphological characteristics (Figure 5.6) to both the Maidstone and Tuna el-Gebel mummies (cf. Lortet & Gaillard, 1905). What has been confirmed is that the individual was positioned with their upper limbs in a flexed position across their chest.

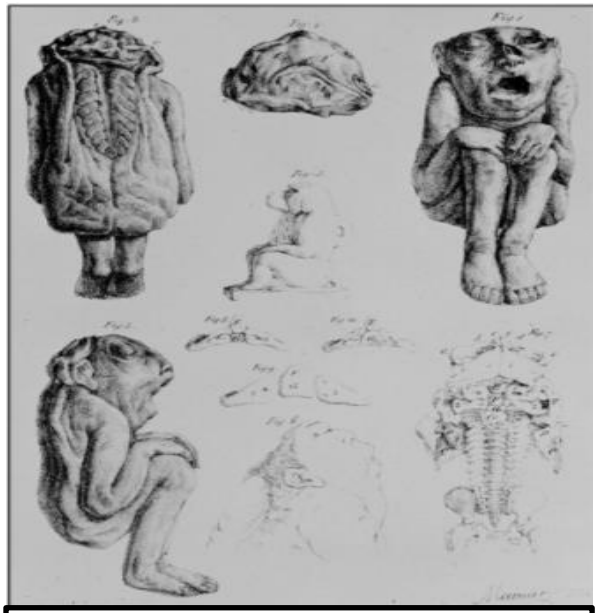

Figure 5.5: The Tuna el-Gebel mummified fetus, illustrated in a flexed seated position with characteristics confirmed to be anencephalic (Geoffrey Saint-Hilaire, 1826: 230).

Certainly further analysis of this particular mummy to confirm the diagnosis of anencephaly would be highly beneficial.

This subsection is meant to illustrate that although rare, Ancient Egyptian mummified fetuses are an area worthy of further inquiry and exploration. At the very least this sample population presents a compelling case for the recognition of personhood within ancient Egypt prior to physical birth without negating the previously stated hypothesis regarding female achievement of personhood later than their male counterparts. These individuals also indicate that those with serious congenital defects may have been taken for powerful animal idols and/or revered for their unique morphology. What each of the above mentioned fetuses suggest is that life was viewed as valuable at each life history stage, even those prior to physical birth. The concept of personhood then, as something that was only achieved throughout life does not entirely seem applicable to Ancient Egyptian culture, seeing as these fetuses were treated with such care and commonly buried with their family (Tocheri et al., 2005). Additional subsequent studies into maternal dietary practices in connection with the prevalence of anencephaly and the significance of this condition within Ancient Egyptian society would be beneficial.

5.5 EXISTING STUDIES: DAVEY & BEYOND

As mentioned in Chapter Two, Janet Davey's analysis of Graeco/Roman subadult mummies is perhaps the most comparable work to this thesis. Although this thesis looks at a wider variety of temporal periods and uses an inclusive lens, rather than a case study approach, comparisons can be made between Davey's findings and those of this thesis.

Figure 5.6: This is a proposed anencephalic fetus, first documented in 1905. Further exploration is required in order to confirm whether this individual was anencephalic. (Lortet & Gaillard, 1905: 237).

Davey hints at the potential for temporal and social variability between individuals, which appears to be confirmed within the results of this study in the Roman Period (Subsections 5.2 & 5.3). Davey argued that evisceration and excerebration were not consistent across the individuals she analyzed (Table 5.2; Craig & Davey 2009; Davey et al., 2014). This

study presents similar findings, as the patterns that were observed within temporal periods were not abundant and the overall mummification style largely showed variation both within and between temporal periods (Table 4.6).

Davey proposed that there may have been differential limb positioning based on sex in Ancient Egyptian subadult mummies. She addressed a study in which she observed that Graeco/Roman Period "females [had] the left hand under the left thigh, the left foot slightly over the right foot and the right hand resting beside the right thigh, while the male [was] positioned in the opposite way" (Davey et al., 2014:84). This claim cannot be further supported by the findings of this study as none of the Roman Period individuals analyzed had their limbs positioned as Davey indicates (Table 4.7). There are of course limitations to studying limb positioning when an inadequate amount of tissue is preserved to maintain articulation of the bones. Without articulation, shifting of the limbs may occur, which may produce false interpretations and trends in limb positioning. This was something that was considered throughout the interpretation of this work's results.

What is perhaps most notable when comparing Davey's findings to those of this thesis is her results surrounding the position of Roman Period subadults' heads. Davey explains that a 'head-down' position [where the mandible is forced to touch the sternum], is seen in "all Graeco/Roman child mummies that have been studied by the authors to date. The reason for this is unknown and appears to be particular to the Graeco/Roman Period" (Craig & Davey, 2009:20). In corroboration with Davey's findings, an additional subadult male, housed at The Vancouver Museum, approximately ten years of age dated to the Roman Period, named Panechates, was also determined to be in the 'head-down' position (Nelson, Personal Communication, 2020). This study further supports Davey's conclusions as 100% of Roman Period mummies under the age of 18 years within this sample population were noted as being in this 'head-down' position. The only Roman Period mummy with their head in a definitively different position (IMP00122) was determined to be between 18 and 21 years of age. The remaining Roman period individual (IMP00022), the Little Girl from Thebes, exhibited a degree of skull fragmentation that made a positional analysis impossible. Contrastingly however, none

of the Graeco (Ptolemaic) Period individuals included in this thesis were found to be in the head-down position.

Table 5.2 – Davey's Existing Findings Summary: This table summarizes the findings of Davey's Graeco/Roman Period research, including each of her 14 mummies. This should be interpreted as follows: 'I' represents 'Indeterminate', 'Y' represents 'Yes', 'N' represents 'No', 'E' represents 'Extended', and 'F' represents 'Flexed'. These findings were reproduced from Davey et al., 2014, Table 3.0: pp.208.

Mummy	~ Age (years)	Sex	Excerebrated	Eviscerated	Arm Position	Hyperflexion of Cervical Spine	Head-down
1. (AIA 1)	6 - 7	I	Y	I	I	Y	Y
2. (AIA 2)	3 - 4	I	Y	I	E	Y	Y
3. (Altdorf)	3.5 – 4.5	M	Y	Y	E	Y	Y
4. (EA30362)	5 - 6	F	I	N	E	Y	Y
5. (EA30363)	6 - 7	F	I	N	E	Y	Y
6. (EA30364)	4 - 5	M	I	N	E	Y	Y
7. (EA22108)	1.5 – 2.5	M	Y	Y	E	Y	Y
8. (EA6723)	1.5 – 2.5	M	Y	Y	E	Y	Y
9. (EA54053)	1.5 – 2.5	I	Y	N	E	Y	Y
10. (NMR26)	4 - 5	M	Y	Y	E	Y	Y
11. (AMM27C)	1.5 - 3	M	Y	Y	E	N	Y
12. (Schleitheim)	2 - 3	I	I	Y	E	Y	Y
13. (Zurich)	5.5 – 6.5	M	N	Y	E	Y	Y
14. (RC22)	4 - 5	I	Y	Y	F	Y	Y

Perhaps the differential head positioning is the result of this individual being viewed as an adult rather than a subadult, which may illustrate another life history transition. This is only one possible explanation for this deviation from the observable pattern, however it is likely the most compelling explanation. Unfortunately, none of the individuals included in Davey's (Table 5.2) allow for further corroboration of this transition, as the oldest individual is approximately seven years of age. If the deviation from this head-down position could be established in more individuals between ages 18 and 21 years within the Roman Period, it may be possible to establish when the transition from subadulthood into adulthood is reflected in the mortuary record within this temporal period. Notably, the transition may be occurring earlier, between Adolescence and Adulthood – between 14 and 18 years of age, however further studies with Ancient

Egyptian mummies around this transition will be required in order to confirm this. Although it does not appear as though there are many marked life history stages reflected in the mortuary record, as may be discerned from the data presented, there is the potential for a marked transition between Adolescence and Adulthood. In order to establish the validity of this prospective diagnostic marker of age in the Roman Period, further analysis is required.

One other notable Roman Period subadult mummy is worth mentioning, although this particular individual does not prove or disprove Davey's hypothesis. ROM Mummy 210.13 is an individual of indeterminate sex, estimated to be less than six months of age at the time of death (Nelson, 2008). What is perhaps the most significant about this individual is that they had an elaborately painted shroud textile that depicted an individual in a 'onesie' (Nelson, 2008). Unfortunately, the head positioning could not be conclusively determined due to a great deal of postmortem shifting, which left the body in a particularly 'scrambled' format (Nelson, 2008). This mummy exhibits signs of evisceration and excerebration, again illustrating that mummification styles within this period were inconsistent (Nelson, 2008). Although this mummy cannot contribute to the findings of Davey, or this thesis, it remains notable given the scarcity of Ancient Egyptian subadult mummies and the unique wrapping in which they were laid to rest.

Additionally, and perhaps most importantly as is observed in Table 5.2, only two of the 14 individuals included in Davey's studies are confirmed females. Notably, these females are amongst the oldest individuals in her sample, although they remain under the age of eight years. This does further support the hypothesis that females generally may have required a longer duration of time to achieve personhood than their male counterparts across Ancient Egypt. Further evidence to support this may be found in other published literature including the British Museum's publication of Ancient Lives New Discoveries (Taylor & Antoine, 2014).

Taylor and Antoine (2014), profile eight Ancient Egyptian mummies from various time periods, only one of which is a subadult female. This individual Tjayasetimu, is said to have been a Chantress from the 22nd Dynasty and is thought to have been approximately seven years of age at her death (Taylor & Antoine, 2014:115). Again, perhaps her status as a Chantress allowed for the achievement of her personhood

prior to her death, thereby leading to her mummification. This cannot be said with certainty, however the prevalence of Chantresses and Princesses within this study and existing literature is certainly cause for consideration.

A similar sentiment is echoed when one reviews the catalogue of mummies present at The National Museum of Antiquities in Leiden (Raven & Taconis, 2005). Of the 29 individuals included in this publication, only seven were confirmed to be female (24.1%). Of those seven, none were under the age of 21 years. Additionally, only seven individuals were determined to be subadults, of which six (85.7%) were determined to be male, with the one remaining being of indeterminate sex (Raven & Taconis, 2005). It appears less and less likely that the low prevalence of mummified female subadults in the Ancient Egyptian record is merely coincidence. This further highlights the validity of the hypothesis that personhood was achieved later in life for females than males, leading to their mummification only at an older age, in the absence of any pre-existing elevated status ascriptions. The literary sources cited above represent a large component of the known existing samples of mummified Ancient Egyptian subadults and are included in the 75 individuals listed in Appendix B.1. This external data set greatly increases the author's confidence in the pattern observed in the IMPACT data set. With that said, future analysis is certainly required to test the validity of this hypothesis.

5.6 MUMMIFICATION STYLES IN ADULTS

It has been suggested that mummification styles were limited and uniform within, and often across, temporal periods, frequently citing the work of Herodotus. This study, in combination with the 2013 study conducted by Wade & Nelson, illustrates that whether one is considering subadults or adults there is "substantial variability in technique and difficulty in performing comparative studies of mummification using the current and classical literature" (Wade & Nelson, 2013: 418). Although there were a couple of discernable trends in the data of this study, these remain speculative due to the small sample size explored. Additionally, variation in mummification style (e.g. excerebration, evisceration, and resin presence) is seen within and between age groups, sex divisions, and temporal periods in both adult and subadult studies.

5.7 SUMMARY

This study presents a novel attempt to distinguish the presence or absence of trends within the limited realm of Ancient Egyptian subadult mummies. This work analyzes the mortuary treatment of these individuals as "the body is the means by which so much of an individual's life experience within a community is facilitated, negotiated, embodied and maintained, [therefore] poignant expressions of the deceased's cultural capacities are often manifested via their bodily treatment in death" (Power, 2011: 97). Although the statistical significance of the trends detected throughout this thesis remains open to question, largely due to the sample size obtained, the results remain compelling.

First, temporal variation in body positioning appears to be confirmed within the subadult population. This confirmation is in large part due to the echoed results seen in published literature of adult Ancient Egyptian mummification analysis (Nelson & Wade, 2013). The similarities in trends seen, specifically in the Ptolemaic Period, both within and between subadult and adult populations, highlight the fact that these patterns were not age dependent, but rather temporally bound. With that said, mummification techniques remain variable in both adult (Nelson & Wade, 2013), and subadult populations.

It is suggested, based on the findings of this thesis, that the marked life history stages referred to by Bogin (2012) either were not recognized, not expressed in postmortem treatment, or simply cannot be discerned, in this study population of subadults. Generally, subadults are treated similarly to adults in terms of mortuary practices, although subadult mummies are not as common as adult mummies (Vandenbeusch & Antoine, 2020). There is however the potential for a marked life history transition between the Childhood and Juvenile stages, as seen in the apparent lack of young female mummies, which may be tied to the concept of personhood and its social achievement. An additional life history transition may also exist between Adolescence and Adulthood within the Roman Period, as identified through the consistent head-down positioning of subadult mummies up until the age of approximately 18 years. Although this is only one time period and one potential diagnostic marker of a recognized transition out of Adolescence it remains significant and worthy of further inquiry.

As a result of these findings, there appears to be a correlation between age and sex in subadult mummies. This data, in corroboration with other published literary sources, (Raven & Taconis, 2005; Davey et al., 2014; Taylor & Antoine, 2014) illustrates the validity of the hypothesis that, in the absence of pre-existing elevated status, females generally achieved personhood at a later age than their male counterparts, which contrasts with the inverse hypothesis presented by Meskell (2000). The hypothesis presented in this thesis is suggested on the basis that subadult Ancient Egyptian female mummies were rare, however even more rare were subadult Ancient Egyptian female mummies under the age of five years. These individuals were so scarce, that other than King Tutankhamun's two fetal daughters, who were evidently of ascribed royal status, there is only one known individual that fits these parameters: the 'Little Girl from Thebes' (c.f. Raven & Taconis, 2005; Davey et al., 2014; Taylor & Antoine, 2014; Conlogue et al., 2021). It would then be argued that a general lack of personhood at younger female ages did not facilitate their mummification upon their death.

This hypothesis clearly requires further examination, however these results hint at a pattern that speaks not only to the beliefs surrounding subadulthood in Ancient Egypt, but also Ancient Egyptian beliefs surrounding social aspects of one's identity, particularly in regard to ascribed and achieved status. Future studies should seek to explore Ancient Egyptian subadulthood paying special attention to the presence of sex differences in mortuary treatment as they relate to age. Additional inquiry into the potential for life history transitions, specifically from subadulthood into adulthood should also be examined. These are merely two applications for future studies, of which there are many surrounding subadulthood in Ancient Egypt. The following chapter will present multiple additional potential research projects within this field while also addressing the limitations of this thesis.

CHAPTER 6

CONCLUSION: AIMS, QUESTIONS & FUTURE APPLICATIONS

This chapter provides a summary of the previous Discussion Chapter, addressing how the results correspond with the research aims and questions posed in this work. Although concrete conclusions are largely lacking, as is often the case when working with archaeological remains, this research and the hypotheses it presents remain valuable and relevant to the realm of Ancient Egyptian studies. Each of the research questions posed in Chapter One will be directly and succinctly answered, based on the findings of this work. Although certainly there were a number of limitations to this study, all of which will be addressed in the pages to follow, this thesis presents a multitude of directions for future research, as there is much still to be learned about Ancient Egyptian subadulthood.

6.1 RESEARCH AIMS

Coming to understand what subadulthood was like for Ancient Egyptians, insofar as it may be determined from the mortuary record, proved to be a difficult task. Although successful osteobiographies were compiled for each of the focal individuals, providing at minimum an age estimation, connecting the age of the individual with a marked life history stage (Bogin, 2012), did not follow. The results did seem to suggest that subadults, although fewer in quantity, were largely treated like contemporaneous adults in death, particularly in terms of limb positioning and method of mummification; this sentiment has been echoed in other publications (Power, 2011; Tennant, 2015). This research may not have uncovered all of what Ancient Egyptian subadulthood was like in life, or in death, however it began an inquiry into a largely unexplored aspect of Ancient Egyptian life.

With the findings derived from the data, very little can be said about the existence of life history stages in Ancient Egyptian, at least in terms of their reflection in the mortuary record. Although individuals from each of Bogin's (2012) life history stages were included within this study, comparisons between these individuals, augmented with adults of a similar temporal period, and consideration for sex, time and age based variables did not allow for the illustration of life history stages. This lack of evidence is not however less valuable than the existence of evidence, as this suggests that life history

stages may not have been prominent in Ancient Egyptian culture, or perhaps they were not reflected in their mortuary treatment.

There is, however, some evidence that suggests the presence of two life history transitions. The first of these is the transition from the Childhood to the Juvenile stage. This stems from the lack of young female Ancient Egyptian mummies seen in the archaeological record. As only one has been documented under the age of five years in this thesis and known published literature, this may suggest that this transition in general, and the various social and physical factors accompanying it, was recognized in Ancient Egyptian culture. Note that of the seven mummies under the age of five years included within this study, three were male, two were suggested males, one was indeterminate, and one, the exception, was female (Table 4.1). This further supports the hypothesis that generally female personhood was only recognized at a later time than it was in their male counterparts. Although this may physically be the case, it appears as though socially this trend is quite the opposite.

Additionally, a life history transition from Adolescence into Adulthood, as reflected in the mortuary record, within the Roman Period may also be observed. This comes from a finding in Davey's works (2009; 2014), which suggest that Graeco/Roman Period subadults were buried in a 'head-down' position. Davey's findings were generally supported by the findings of this thesis, for the Roman Period, and so, if this posture was unique to subadults during this time period, which does appear to be the case, the 18 – 21 year old individual in this sample, who is from the Roman Period, and is not positioned 'head-down', may illustrate a marked transition from Adolescence to Adulthood as reflected in the mortuary record. Although this conclusion cannot be confirmed at this time, it is certainly an area that would benefit from further inquiry. Perhaps an investigation into whether such a transition is present in the Roman Period elsewhere would be beneficial.

Consider that given the existence of a few known Ancient Egyptian mummified fetuses, as mentioned previously, the argument is made that 'personhood' was, at least in some rare cases, developed and recognized prior to physical birth in this civilization. This would tie in part into the concept of ascribed status, which is perhaps the most likely explanation for the careful mummification of King Tut's two fetal daughters. Generally,

it should also be stated that not all Ancient Egyptian subadults were mummified, rather very few were (Power, 2011). This hints at an underlying influential variable, most likely status or disfiguring congenital conditions such as anencephaly, which dictated who was worthy of mummification.

Additionally, a strong argument may be made for the recognition of achieved status as an explanation for the general absence of female subadult Ancient Egyptian mummies of less than five years of age. Seeing as this study, Davey et al.'s studies (2014), The British Museum's publication (2014), and the Leiden catalogue (2005) combined included only one female individual less than the average age of the mummified males in this study (7.7 years), this trend appears to be significant. Perhaps the most logical explanation for the absence of these females is that they were not able to achieve personhood until later than their male counterparts, leading to fewer young females being mummified and therefore their general absence in the mortuary record. Although admittedly, the amount of achievement that one would be capable of at the age of five remains questionable. The sole exception known at this time is the 'Little Girl from Thebes' (Conlogue et al., 2021) who illustrates that at least some young girls were able to establish personhood.

Additionally, the variation seen across mummification styles (excerebration, evisceration, resin use) within this study aligns well with previous publications about mummification in adults (e.g. Wade & Nelson, 2013). The number of inconsistencies between age, temporal, and sex-based parameters in both adults and this subadult population was generally no greater than the amount of variation within these age, temporal, and sex-based divisions. This would suggest that mummification was not a rigidly standardized practice with a limited number of protocols or procedures, but rather the "mortuary rituals that were practiced at any given time were reflections of the beliefs, influences, and cultural mores of the time" (Wade & Nelson, 2013: 4206).

Although each of the findings presented in this thesis are only the beginning of an inquiry into a complex, and largely untouched area of archaeology they remain pertinent to the field of Anthropology. Providing each of the focal individuals with an osteobiography allows for a better understanding of their identity in life, and in death.

6.2 RESEARCH QUESTIONS

This subsection will restate each of the research questions posed in Chapter One of this thesis and succinctly answer them based on the findings of this study.

1. Were subadult Ancient Egyptian mummies treated differently in death than their adult counterparts?

The results of this work suggest that Ancient Egyptian subadult mummies were generally not treated differently than known adults. There are however, two caveats to this conclusion: young female Ancient Egyptian mummies and Roman Period subadult mummies. There appears to be a hole in the archaeological record surrounding young female Ancient Egyptian mummies, as only one documented individual under the age of five years (with the exception of King Tut's two fetal daughters and the 'Little Girl from Thebes'), is known to this author. Additionally, Roman Period subadult mummies less than 18 years of age, generally illustrate a unique head-down position, which does not seem to appear in any other population. Furthermore, the rarity of fetal mummies suggests that personhood may have been granted to Royal and malformed fetuses. However, it appears to have been ascribed at birth in males and either ascribed or achieved at a later age in females. Beyond these examples of differential treatment, adults and subadults were generally treated similarly.

2. If subadult and adult Ancient Egyptian mummies are treated differently, do these differences reflect Bogin's life history stages, as may be discerned by analyzing their postmortem treatment?

The results of this work do not suggest that there are marked life history stages present within Ancient Egyptian culture, at least as is reflected in their mortuary treatment, as adults and subadults were largely treated in the same manner posthumously. Variability in mummification style and similarities seen between known adult populations do not support the presence of life history stages as outlined by Bogin (2012). The results do however present the potential for two marked life history transitions that align with Bogin's (2012) conclusions. The first is that there may be a transition seen between the Childhood and Juvenile stages in young female mummies at the age of five years. The general absence of these individuals, save for one exception, in the mortuary record may arguably be tied to the concept of personhood, as females may

have only achieved this at a later age than their male counterparts, contrary to Meskell's (2000) hypothesis. The second life history transition occurs between Adolescence and Adulthood, particularly in the Roman period, which may be observed by a change in head positioning. Further analysis is required to either confirm or refute these findings.

3. Do geographic and/or temporal variations exist in terms of the mummification of these subadults, and if so, are these trends consistent with those observed in adults of the same geographic and/or temporal division?

Geographical variations could not be addressed within the scope of this study due to a lack of known provenience. Further complicated by the mummy trade, which took place for centuries, it became largely impossible to trace where these focal individuals originated from geographically speaking. For this reason no claims are made for, or against, geographical variation in this subadult Ancient Egyptian sample. Temporally, there do appear to be some trends that arise throughout the study, which also correlate with known adult populations, their significance is however difficult to determine. It appears as though stylistic arm positioning changes may be detected across time, which are consistent between subadult and adult populations. Additionally, the Roman Period head-down positioning of subadults reported by Davey appears to be confirmed within this study population, whereas the Ptolemaic Period did not yield such conformational results. The findings of this work largely suggest that temporal trends seen in the subadult study population mirror known contemporary adult trends. Notably, these trends remain scarce, which further confirms the variability across temporal periods recognized by Wade and Nelson (2013).

6.3 LIMITATIONS OF THIS STUDY

As mentioned throughout this work, this thesis is not without limitations. Perhaps the most notable and frequently reoccurring limitation was the small sample size (n = 21). When working with a small number of individuals, statistical significance must always be questioned. The salience of trends is difficult to distinguish when the population being analyzed may be presenting patterns that are not indicative of the overarching patterns existing within the entire population of subadult Ancient Egyptian mummies, however this study has consulted other publications in order to address this concern as much as possible. Additionally, having only ten individuals who were CT scanned, or physically

analyzed, made the compilation of osteobiographies for the remaining ten X-rayed individuals challenging. Having said this, this remains the single largest sample of subadult mummies studied in one project.

When working with various X-rays of unknown magnification, taking quantitative measurements (e.g. long bone lengths) is difficult due to the inability to correct for said magnification. This would have resulted in inaccurate measurements, and therefore skewed age estimations. X-rays cannot be manipulated in the same fashion as CT scans, which also meant that obtaining visible views of the pelvis was extremely difficult, if not impossible, in many cases. Available X-ray images varied greatly in terms of clarity and positioning and so were difficult to interpret particularly in terms of detecting if evisceration and excerebration had occurred. All of these limitations were fortunately negated when working with the CT scans as manipulation, segmentation, and measurements were undertaken with ease.

Although areas of study with very little known published literature are a researcher's dream, as was the case with Ancient Egyptian subadulthood, this lack of existing information can also be difficult. Without a foundation of knowledge to build upon, inquiries into ancient civilizations can often lead to persuasive hypotheses, rather than concrete conclusions, as was largely the case in this study. The findings of this work remain important and valid, however they are only the beginning of what could very well be a great deal of inquiry into this section of Ancient Egyptian culture. The hope is that this thesis can work as the foundation upon which future research into Ancient Egyptian subadulthood may flourish, thereby negating this limitation for future scholars.

6.4 FUTURE RESEARCH OPPORTUNITIES

Throughout the entirety of this work the applications of future research have been mentioned, as they are plentiful. In a realm of very limited knowledge, the possibilities for subsequent research are essentially endless. One of the most compelling topics addressed within this work is the Ancient Egyptian fetuses. These mummified individuals, although rare, present an interesting window into the way in which Ancient Egyptians viewed life, the onset of it, the end of it, and the value of it prior to physical birth. Very little examination of these individuals has been conducted, and so future

research projects may endeavour to better understand their significance, particularly in terms of the tie between anencephalic fetuses and animal contexts.

Furthermore, each of the trends addressed in this thesis require subsequent research in order to truly substantiate them. Inquiries into temporal, sex-based, and age related differences, which compare and contrast the findings of this work would be highly beneficial. The key to producing such studies is establishing a sample size large enough to produce convincing and compelling patterns, which may then be used comparatively. Although this is certainly not an easy task given the limited number of known subadult Ancient Egyptian mummies, additional imaging of known individuals would be a step in the right direction, as knowledge mobilization is always a fundamental component of research.

With additional time, dedication, and research, the secrets that exist within Ancient Egyptian subadulthood should begin to unveil themselves. Coming to understand the social and physical identity of subadults in Ancient Egypt and how these identities were reflected in their mortuary treatment provides insight not only into subadulthood, but also into the society as a whole. The findings of inquiries into ancestral populations are innately valuable as they provide glimpses into the past, while also having modern applications. Future researchers are called to remember that the past truly is the key to the present.

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APPENDIX

NESMUT: A FIRST HAND OSTEOBIOGRAPHICAL STUDY

This thesis presented a unique opportunity to complete a first hand osteobiographical case study of a subadult Ancient Egyptian mummy named Nesmut (ROM Catalogue Number 910.268.1). She has been dated to the Twenty-second Dynasty (940 – 720 BC) and is housed at the Royal Ontario Museum in Toronto, Ontario (Gibson & Trumpour, 2006). On September 23, 2019, a skeletal inventory and a series of both quantitative and qualitative observations were made, which were tailored to building her osteobiography, particularly in terms of providing an estimation of both age and sex. On December 13, 2019, a follow-up examination was conducted, which focused on procuring additional photographs, particularly of her dentition, while also obtaining a series of X-ray images. The findings of this research will be explored throughout this Appendix.

Nesmut, apparently from Gurneh, was unwrapped in the 1960s, and is now only represented by her skeleton and a small amount of preserved soft tissue (Gibson & Trumpour, 2006). This subadult mummy presents an intriguing case study, as her accompanying coffin, which is believed to belong to her, as it is the appropriate size (Figure A.1), was inscribed with the titles she held during her life: "Lady of the House, Chantress of Amun-Re" (Gibson & Trumpour, 2006). Initially it had been assumed that this title was generally not held by subadults, however a further exploration of this title and its significance will be presented in subsequent sections. This comprehensive case study will present the findings of this primary osteobiographical

Figure A.1: Nesmut's elaborately adorned coffin. (Gibson & Trumpour, 2006).

analysis of Nesmut's remains, in order to attempt to better understand how subadulthood in Ancient Egypt was reflected in the mortuary program.

A.1 MATERIALS & METHODS

With the permission of the Royal Ontario Museum, the materials used throughout this osteobiographical analysis included: the mostly skeletonized remains of Nesmut, a digital calliper, a magnifying glass, a photo scale, latex gloves, a portable X-ray plate (an Aero Mobile Digital Radiography System), an X-ray machine (a Faxitron), a laptop in which to store the X-ray images obtained, a digital camera, and the checklist developed specifically for the analysis of Nesmut's remains (Appendix A.1).

Figure A.2: Nesmut's partially skeletonized remains upon her unwrapping in the 1960s (Gibson & Trumpour, 2006).

When she was unwrapped, Nesmut was already largely skeletonized (Gibson & Trumpour, 2006), although some connective tissue was preserved, particularly surrounding the major long bones and facilitating the articulation of the rib cage in anatomical position (Figure A.2). It should be noted that Nesmut was not excerebrated, which became readily apparent upon the examination of her remains and the existing X-rays, which confirmed the existence of residual cerebral tissue. She was however noted as having "globs of resin" (Peever, Personal Communication with G. Gibson, 1992) included within her wrappings, which may have hinted at an elevated social status (cf. Wade & Nelson, 2013). Nesmut was measured at three feet nine inches in length (Peever, Personal Communication, 1992), which would make her stature consistent with

that of a modern North American six year old (National Center for Health Statistics & Centers for Disease Control and Prevention, 2020).

In order to provide meaningful age estimates, diagnostic aging standards including epiphyseal fusion (McKern & Stewart, 1957), and dental formation/eruption (Moorrees, Fanning & Hunt, 1963; Ubelaker, 1987; Hass et al., 1994), which were detailed throughout the body of this work, were employed. Additionally, ethical principles surrounding respect for human remains and non-invasive analysis were consistently considered and applied throughout the analysis (cf. Lonfat, Kaufmann & Rühli, 2015).

A.2 RESULTS

For the sake of clarity, the results will be broken down into subsections, in which the appropriate findings will be presented. All interpretations of these findings will be presented within the subsequent 'Discussion' section.

A.2.1 SKELETAL INVENTORY

The skeleton of Nesmut was largely complete with the exception of the right scapula, patellae, and the majority of the tarsals and metatarsals. The left fibula and ulna were both fractured, likely post-mortem. Notably, a large amount of soft tissue was preserved around the pubis/ischium and lower anterior abdomen, with a separate section of soft tissue surrounding and the right upper limb, which holds her humerus, radius, ulna, carpals, metacarpals, and phalanges in anatomical position (Figure A.3).

Figure A.3: Nesmut's rearticulated body, complete with residual soft tissue (Graves & Nelson, 2019).

A.2.2 AGE ESTIMATION: EPIPHYSEAL FUSION

Due to the preservation of proximal soft tissue on Nesmut's long bones, establishing the degree to which her epiphyses were fused or unfused was largely impossible by visual inspection, including the fusion of the hamate hook. Once X-rays were obtained however, it became apparent that all of the major epiphyses remained unfused, as did the hamate hook (Figure A.4), leading to an age estimation of less than nine years (McKern & Stewart, 1957).

A.2.3 AGE ESTIMATION: LONG BONE LENGTHS

Table A.1: Nesmut's Long Bone Length Measurements – each of the below long bones was measured at its maximum length, in centimeters, using a digital calliper, except those with the *, which represent diaphyseal length. The age range associated with each measurement is presented in the final column (Ruff, 2007).

Bone	Measurement (cm)	Age Range
Humerus	Left: 20.3* Right: 20.5*	7 – 8 years
Femur	Left: 28.9 Right: 28.8	7 – 8 years
Tibia	Left: 24.3 Right: 24.4	7 – 8 years
Fibula	Left: Fractured Right: 23.8	N/A
Radius	Left: 15.0 Right: Articulated	7 – 8 years
Ulna	Left: Fractured Right: Articulated	N/A

A.2.4 AGE ESTIMATION: DENTITION

Nesmut presented with an erupted first permanent molar, however her second and third molars had not yet erupted (Figure A.5). There was also apparent occlusal surface wear presenting with bilateral symmetry on the first molars indicating that they were in full occlusion. The second and third molars (M2 and M3) are the last teeth to enter crown and root formation and therefore they are the last to erupt (Moorrees, Fanning & Hunt, 1963; Ubelaker, 1987; Hass et al., 1994; Smith, 1991). Crown formation in the second molar generally occurs between the ages of four and six years. The root of M2 then forms between the ages of six and 11 years, followed by eruption between 11 and 15 years. The third molar develops much later, with the crown formation occurring between ages 10 and 12. The M3 root development occurs between ages twelve and seventeen,

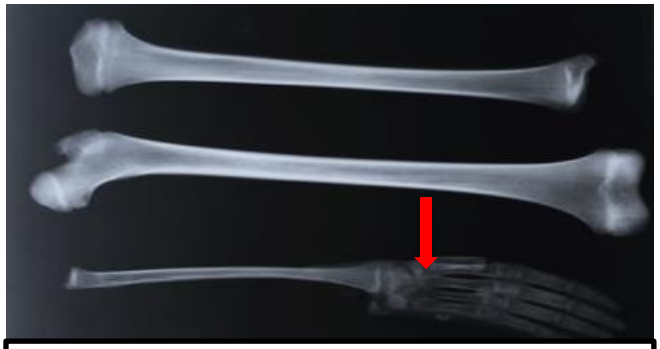

Figure A.4: X-rays of Nesmut's lower limb (top 2 images) and articulated forearm with hand, illustrating the unfused epiphyses and unformed hamate hook. The hamate hook is denoted by the red arrow. (Graves & Nelson, 2019).

with eruption following between ages 17 and 21 (Moorrees, Fanning & Hunt, 1963; Ubelaker, 1987; Smith, 1991; Hass et al., 1994). No wear was observed on the surface of the mandibular incisors, which in this case is not indicative of age; rather it is consistent with her observed overjet of the maxillary incisors (see below). With all of this information in mind, Nesmut's age was estimated to be between the age of six and eight years.

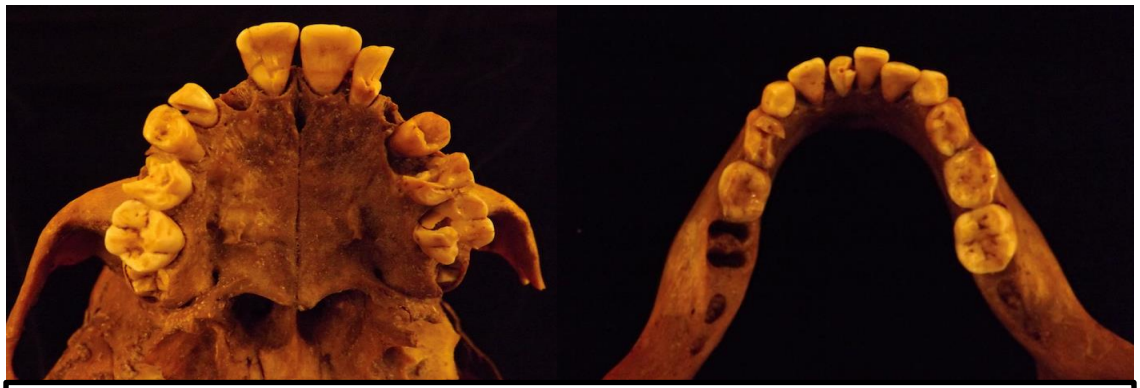

Figure A.5: Nesmut's upper maxillary (left) and lower mandibular (right) dentition, reflecting the eruption of her first molars and the non-eruption of her second and third (Graves & Nelson, 2019).

A.2.5 DENTITION: CEPHALOMETRIC ANALYSIS

Nesmut's overjet was classified by Dr. Drew Smith (www.smithorthodontics.ca), a local orthodontist and alumnus of The University of Western Ontario, as a large class II malocclusion, which is defined as a dental pattern in which there is imperfect positioning of the teeth when the mouth is closed. This involves a molar relationship in which the buccal groove of the mandibular M1 is positioned distally when in occlusion with the maxillary M1(Smith, Personal Communication, 2020). Further analysis was completed with the use of dental cephalometric imaging technology (Figure A.6), which was determined to differ from both modern North American and Egyptian cephalometric norms (Smith, Personal Communication, 2020). Nesmut also presents a retrognathic mandible, which means that her mandible is located more posterior than the average

person's in comparison to the remainder of her facial skeleton (Smith, Personal Communication, 2020). With these findings, Nesmut's facial structure was classified as dolichocephalic, meaning she had a longer lower face than average due to a steep mandibular plane (Smith, Personal Communication, 2020). It should also be noted that with her class II malocclusion (where the maxillary dentition positioned in an anterior position relative to the mandibular dentition), being as severe as it was, would likely have made it difficult or impossible for her to close her lips without considerable strain, thereby making her more susceptible to gingival inflammation (Smith, Personal Communication, 2020).

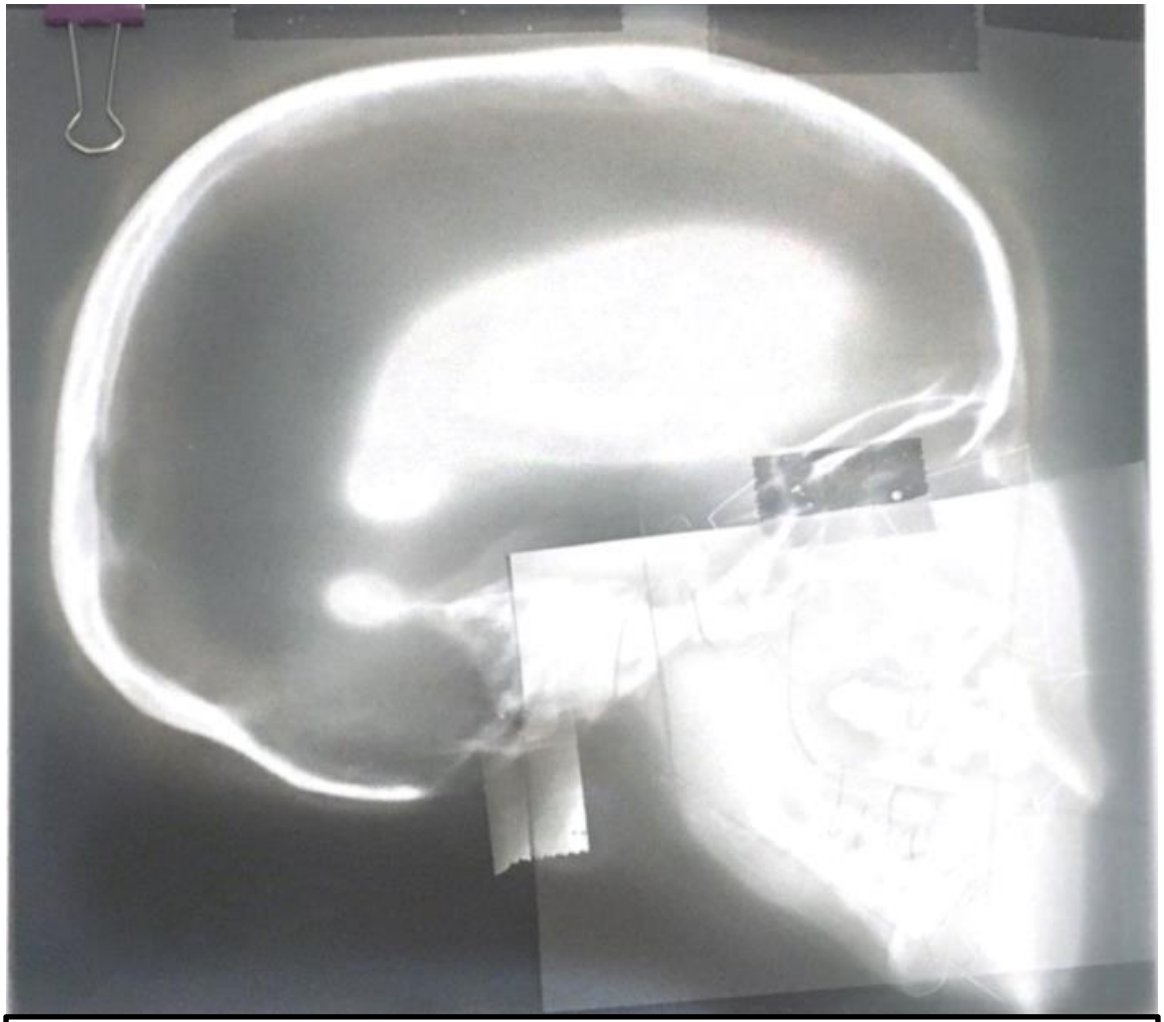

Figure A.6: Nesmut's cephalometric lateral X-ray photo, showing her irregular pronounced overjet (Smith, 2019).

A.2.6 SEX ESTIMATION

A large amount of soft tissue surrounding the pubis/ischium and part of the anterior abdominal wall was preserved, which exhibited features that correspond to a vaginal opening associated with the adherence of the pubic bones and mons pubis (Figure A.7), Nesmut was confirmed to be female.

A.2.7 PATHOLOGY

Nesmut did not present with any gross pathological conditions, however some lesions were observed. These lesions included a 2mm deep, 0.35mm in diameter skull perforation on the sagittal suture, located 9.4mm behind bregma (Figure A.8). Nesmut's right mandibular condyle also demonstrated a small defect, measuring 4.5mm by 3.5mm at its greatest length (Figure A.9). A slight lesion was also observed on the left mandibular condyle, which may suggest overuse of the jaw at the temporomandibular joint. The right proximal posterior diaphysis of Nesmut's tibia exhibited a 9.3mm by 7.6mm lytic lesion, which was not present on the left side (Figure A.10).

A.3 DISCUSSION

The discussion component of this case study will be broken into three subsections, which include: Nesmut's osteobiography (age and sex estimations), differential diagnosis of pathological findings, and the relationship between Nesmut's apparent age and the titles she was said to hold during her life.

A.3.1 NESMUT'S OSTEOBIOGRAPHY

As mentioned in the body of this work, taking a literal approach to the definition of osteobiography, the term "osteo" is a prefix that means "bone", while the word "biography" is an account of an individual's life, which was composed by another person (Saul & Saul, 1989). The term in totality then may be defined as: the reconstruction of the deceased's life as told by their physical bony, and in some cases soft tissue, remains. As discussed above, it was determined that Nesmut's dentition best corresponded to an age

Figure A.7: The large piece of residual soft tissue surrounding Nesmut's ischium (Graves & Nelson, 2019).

estimate between six and eight years. This age estimate was primarily based on the eruption of her first molar combined with the lack of development seen in her second and third molars. Additionally, a second independent age estimate was obtained from Nesmut's long bone measurements, while also considering the limited epiphyseal fusion results. When compared to other study populations (e.g. Maresh, 1955; Ruff, 2007), Nesmut's long bone measurements suggested that she was between the ages of seven and eight years. This is again consistent with the lack of observed epiphyseal fusion (McKern & Stewart, 1957), as well as the absence of the hamate hook (Lewis, Shapland & Watts, 2015), all of which occur after this age category.

These estimates correlate well with one another, providing a consistent age estimate for Nesmut (six to eight years), which allows for the completion of one component of her osteobiography. Notably, according to Bogin's (2012) age classifications, which are addressed throughout this work, Nesmut falls right on the cusp between the 'Childhood' and 'Juvenile' stages. Additionally, with the presence of soft tissue around her pubis/ischium, Nesmut's sex was confirmed as female, further completing said osteobiography. This was also consistent with the text found on her coffin (Gibson & Trumpour, 2006). It should be noted that finding preserved soft tissue, which is indicative of the individual's sex is uncommon, however, as mentioned in Chapter Three of this thesis it has been observed previously in the realm of mummy studies (e.g. Morimoto, 1989; Davey, Stewart & Drummer, 2013).

Figure A.8: The 2mm deep, 0.35mm in diameter lesion located 9.4mm behind bregma on Nesmut's skull (Graves & Nelson, 2019).

A.3.2 DIFFERENTIAL DIAGNOSIS OF PATHOLOGICAL LESIONS

The cause of Nesmut's premature death could not be established based on the minor pathological lesions that were documented. The small lytic lesion on the tibia is

likely the result of a posterior cruciate ligament (PCL) avulsion fracture (Jazayeri, Jah & Karami, 2009; Nelson, Personal Communication, 2020). Alternatively, and perhaps equally likely is that this lytic lesion is the result of a tear at the origin point of the popliteus and thus is an osteochondritis dissecans (OCD) lesion (Brown et al., 1995; Nelson, Personal Communication, 2020; Waters-Rist, Personal Communication, 2020). Furthermore, the small defect in Nesmut's right mandibular condyle may be consistent with another osteochondritis dissecans lesion, which is again the result of an overuse injury (Ubelaker, 1987; Waters-Rist, Personal Communication, 2020). As these OCD injuries remain a true enigma, there is no reason to suggest that the two lesions point toward an identifiable underlying pathological condition (Garrett, 1991; Wall & Stein, 2003). However, it is unlikely that the precise cause of this overuse can be definitively determined. One confounding variable that may have contributed to this overuse lesion is Nesmut's severe malocclusion and the inconsistencies in the way that her mandible and maxilla aligned.

It should also be stated that Nesmut's malocclusion was severe enough that it was likely outwardly disfiguring, and quite possibly would have made singing, as a Chantress, complicated (Smith, Personal Communication, 2020). The social ramifications of this malocclusion cannot be known, however the fact that she continued to hold significant titles in her community and was mummified upon her death, suggests that she was not a lower class citizen, either monetarily or socially.

Figure A.9: Nesmut's right mandibular condyle exhibiting a small 4.5mm by 3.5mm lesion, consistent with an osteochondritis dissecans lesion (Graves & Nelson, 2019).

An alternative hypothesis for this pathological condylar lesion is that it was the result of a small sub-chondral cyst (Lapointe, Personal Communication, 2020; Pynn, Personal Communication, 2020), however confirming this remains largely impossible.

With that said, an osteochondritis dissecans lesion remains likely, particularly due to her malocclusion (Waters-Rist, Personal Communication, 2020).

The skull perforation is not as easily explained, as this particular lesion is not consistent with any other observable published literature. It should be noted that this lesion did not penetrate the skull, but as stated previously, was only 2mm deep with outwardly bevelled edges. Given the location of the lesion, at first glance, it was proposed that this was a modern attempt to hang Nesmut's skull vertically on a mount. However, the outward bevelling around the hole, in addition to the fact that it did not penetrate the skull, makes this highly unlikely. One other possibility for the small skull lesion, which seemed plausible upon initial inspection, is that it is of a taphonomic nature. It was thought that perhaps a beetle had burrowed out of Nesmut, causing the outward bevelling around the lesion. This was quickly disproven however as there is no residual soft tissue, rather only bone remains where the lesion sits. It would have therefore been largely impossible for a beetle to exit the skull without a point of entry or a path to the exit. Although this lesion has been thoroughly researched, there does not appear to be a reasonable cause documented in the existing literature. It must therefore be stated that these inconclusive results indicate that what or who caused this pathological finding remains unknown. It should be stated that this lesion might be within the range of normal anatomical variation, at which point it is no longer considered pathological.

Figure A.10: The diaphysis of Nesmut's right proximal tibia displaying a 9.3mm by 7.6mm lytic lesion (Photo: Graves & Nelson, 2019).

It had been proposed that this skull lesion, and potentially the others mentioned above, were consistent with thalassemia. This condition is a disorder of the blood, which has been known to leave diagnostic skeletal markers and is known to occur in certain Mediterranean countries (Steinbock, 1976). Although this conclusion was quickly dismissed, this potential explanation then called for an in depth analysis of the diagnostic markers of thalassemia and their correlation to Nesmut's remains. To examine this

within the scope of a differential diagnosis, consider that thalassemia tends to facilitate cranial diploic vault expansion (Carrey, 1951; Steinbock, 1976; Ortner & Putschar, 1985). Nesmut does not exhibit any evidence of diploic vault expansion and her frontal bone has an appearance within the range of normal (Figure A.6). The next marker of thalassemia involves the incomplete pneumatisation of cranio-facial sinuses and the temporal bone (Steinbock, 1976). Nesmut's sinuses appear to be within the normal range for an individual six to eight years of age; additionally, her pneumatisation appears complete. The final facial characteristic associated with thalassemia is the expansion of the maxilla, leading to malocclusion, commonly referred to as 'rodent facies' (Steinbock, 1976; Ortner & Putschar, 1985). This is perhaps the most convincing characteristic when compared to Nesmut, as she does have an overjet (Figure A.6). However, her maxilla does not appear to be inflated, with the spacing between her teeth remaining in the normal range (Figure A.5).

Additional, perhaps less diagnostic, physical indicators of thalassemia include expansion of marrow cavities, particularly in the metacarpals, femura, and ribs (Steinbock, 1976). There is no evidence to suggest that Nesmut experienced any marrow cavity expansion (Figure A.4). These findings have all been summarized in the differential diagnosis table included below (Table A.3). Although thalassemia was considered as a diagnosis and explanation of all of Nesmut's pathological lesions, the differential diagnosis indicates that this is not the cause of these lesions. The prior explanations for the tibial, skull, and mandibular condyle lesions remain favoured.

Table A.2 – Nesmut's Thalassemia Differential Diagnosis: This table explores the differential diagnosis of thalassemia as it relates to Nesmut's physiological remains. References for each finding may be found in the section A.3.2.

Diagnostic Marker of Thalassemia	Presence in Nesmut
Cranial Diploic Vault Expansion	Not present
Incomplete Pneumatisation of Cranio-Facial Sinuses & Temporal Bone	Not present
Expansion of Maxilla leading to Malocclusion	Overjet present, no expansion of maxilla
Expansion of Marrow Cavities	Not present

A.3.3 NESMUT'S TITLE IN RELATION TO HER AGE

Nesmut's coffin was inscribed with the word 'šmᶜyt', which has now been translated to either "Singer", "Songstress", or "Chantress" (Onstine, 2001:8). It was this elaborate adornment on her coffin that presented both her name and the titles she held in life. Notably, it had previously been assumed by the author that titles such as Nesmut's, "Lady of the House, Chantress of Amun-Re" were reserved for adults. Although there is a very limited amount of literature surrounding Chantresses and their titles in Ancient Egypt, what is available seems to contradict this initial hypothesis. It has been noted that in the Twenty-First Dynasty, which immediately preceded Nesmut's, "there is some evidence that children held the title [of Chantress]" (Onstine, 2001:94).

Although age does not appear to be influential in obtaining the titles Nesmut held, there were three governing factors that appeared to dictate the decision of a woman to participate as a šmᶜyt. First, it appears as though a familial allegiance to one particular cult, in Nesmut's case the cult of Amun, ("Chantress of Amun-Re"), was important (Onstine, 2001). Next, "the influence a particular cult had in the local community was also a consideration...[as the] community of elite officials and wealthy members of the middle class were usually involved in the dominant state religious institutions" (Onstine, 2001:96). Finally, depending on the age of the individual, either a sense of personal or perhaps ascribed calling or piety seemed to be significant as it accounted for the "individual's desire to carry out religious duties" (Onstine, 2001:96). This premise is further supported by the fact that within families not all daughters were afforded the title, speaking to the fact that some were perhaps more pious than others.

With this information in mind, it would seem as though Nesmut's age was a less significant contributing factor than her social status. Her titles likely provide insight into her socioeconomic status, as "it is probably accurate to assume that women who were allowed to participate in the official religious hierarchy of Egypt were of at least middle class background" (Onstine, 2001:97). This concept is further supported by the fact that the "average woman [would not] have had time for responsibilities outside her home and family" (Onstine, 2001:97). It would therefore appear that Nesmut was a subadult who likely came from a middle class or elite family, which is supported by the fact that she was mummified, in combination with her elaborately decorated coffin. Her family was

likely a part of the cult of Amun, which would have been very common during the Twenty-Second Dynasty, resulting in the inclusion of "Amun-Re' within her title (Onstine, 2001). Finally, the evidence suggests that Nesmut would have felt a sense of divinity or piety, creating her willingness to serve a religious purpose as a Chantress. These findings should be considered in combination with the other Chantresses mentioned in this study, as detailed in Chapter Five Sections 5.3 and 5.5.

A.4 CONCLUSIONS

A thorough first-hand analysis of Nesmut, a Twenty-second Dynasty mummy, now largely skeletonized, allowed for both the confirmation of her sex as female, and a credible age estimate between six and eight years. According to Bogin's (2012) life history stages, this would mean Nesmut was transitioning out of the etically defined 'Childhood' stage and into the 'Juvenile' stage at the time of her death. This is significant given the fact that her elaborately adorned coffin was inscribed with the title "Lady of the House, Chantress of Amun-Re", which was previously assumed to be a title exclusively held by adults. This assumption was however likely incorrect, as social status and personal piety appeared to dictate who held these titles, rather than one's age (Onstine, 2001).

It is likely that Nesmut's sense of divinity at what is perceived to be such a young age by modern standards, in combination with her elevated socioeconomic background afforded her the lavish mortuary treatment she was given (her mummification and adorned coffin). This research supports the concept that subadults were capable of being recognized as people of importance who contributed valuable service in life, which was then reflected in their mortuary treatment. This ties directly into the hypothesis presented within this thesis, which states that, in the absence of ascribed royal status differentials, males have personhood, and are therefore mummified from birth on, whereas females generally do not achieve it until the age of about five years. Whether it was Nesmut's high ranking familial ties, her contributions as a pious Chantress, or a combination of these factors that led her to the mortuary treatment she was given unfortunately cannot definitively be stated. However, this osteobiographical analysis has provided a great deal of information regarding who Nesmut was, a pious roughly six to eight year old female, with only minor pathological markers, who likely came from a middle class to elite

family associated with the cult of Amun. Although there are still questions left to be answered surrounding Nesmut, a large component of her story and identity has now been discerned, which is the marker of a successful osteobiographical study.

ASSOCIATED ACKNOWLEDGEMENTS

This case study would not have been possible without the support and assistance of many key people at The Royal Ontario Museum. I would like to extend my sincerest gratitude to each of the following individuals:

Gayle Gibson, Volunteer

Cheryl Copson, Egypt and West Asian Collection Technician

Jean Dendy, Senior Conservator

Krzysztof Grzymski, Senior Curator of World Cultures

APPENDIX A.1: NESMUT'S DIAGNOSTIC CHECKLIST

NESMUT: ROYAL ONTARIO MUSEUM **Monday, September 23, 2019**

Feature	Findings
Femoral Head Epiphysis	L: Indeterminate / 0 / 1 / 2 R: Indeterminate / 0 / 1 / 2 **Attached**
Distal Femoral Epiphysis	L: Indeterminate / 0 / 1 / 2 R: Indeterminate / 0 / 1 / 2 **Attached**
Distal Tibial Epiphysis	L: Indeterminate / 0 / 1 / 2 R: Indeterminate / 0 / 1 / 2 **Attached**
Distal Fibular Epiphysis	L: Indeterminate / 0 / 1 / 2 R: Indeterminate / 0 / 1 / 2 **Attached**
Humeral Head Epiphysis	L: Indeterminate / **0** / 1 / 2 R: Indeterminate / 0 / 1 / 2 **R = Attached**
Medial Clavicle Epiphysis	L: Indeterminate / **0** / 1 / 2 R: Indeterminate / **0** / 1 / 2 **NOT present**
Hamate Hook	L: Absent Indeterminate Present R: Absent Indeterminate Present **Attached**
Greater Sciatic Notch	L: 1 / 2 / 3 / 4 / 5 R: 1 / 2 / 3 / 4 / 5 **Could not be determined**
Subpubic Angle	Concave / Indeterminate / Convex **Could not be determined**
Preauricular Sulcus	L: 1 / 2 / 3 / 4 R: 1 / 2 / 3 / 4 **Could not be determined**
Pubic Symphysis	Todd Phase Estimate: Suchey-Brooks Phase Estimate: **Could not be determined**
External Genitalia	**Present** / Indeterminate / Absent Details: soft tissue preserved – appearing between pubis / ischium is consistent with vagina (photographed).

IMPACT Diagnostic Checklist

NESMUT: ROYAL ONTARIO MUSEUM Monday, September 23, 2019

Bone	Measurement (mm)
Length of Humerus	L: **203** R: **205** Epiphyseal OR **Diaphyseal**
Length of Femur	L: **289** – max epiphysis in place 290 R: **288** – max epiphysis in place 290 Epiphyseal OR **Diaphyseal**
Length of Tibia	L: **243** R: **244** Epiphyseal OR **Diaphyseal**
Length of Fibula	L: **N/A missing piece mid shaft** R: **238** Epiphyseal OR **Diaphyseal**
Length of Radius	L: **150** R: **N/A - articulated** **Epiphyseal** OR Diaphyseal
Length of Ulna	L: **N/A fragmentary and proximal articulation** R: **N/A articulated** Epiphyseal OR Diaphyseal

IMPACT Diagnostic Checklist

NESMUT: ROYAL ONTARIO MUSEUM **Monday, September 23, 2019**

Feature	Observations
Known Provenience	
Wrappings	
Head Positioning	
Limb Positioning	Arms: Extended, palm on outer thigh. Legs:
Pathology	
Hair	Yes, fragments up to 10cm long, brownish in colour, some still attached to scalp fragments.
Grave Goods	
Miscellaneous	

MUMMIFICATION

Cribiform Plate	**In tact** / Indeterminate / Broken
Excerebrated	**No** / Indeterminate / Yes
Resin in Cranium	**No** / Indeterminate / Yes
Eviscerated	No / **Indeterminate** / Yes

CONCLUSIONS:

Sex Estimation	0 / 1 / 2 / 3 / 4 / 5 Details: **Vagina present – female.**
Age Estimation	Details: **6 – 8 years, dental eruption, long bone length.**

APPENDIX B.1: TABLE OF KNOWN SUBADULT ANCIENT EGYPTIAN MUMMIES

This table lists all of the known subadult Ancient Egyptian mummies excluding those included in this study (n = 75). The table has been sorted by approximate age at death (lowest to highest) according to the upper component of the age range.
References may be found following the table.

Name	Period	Location	~ Age (years)	Sex Estimation
Child Mummy in a Pot[1]	Unknown	Museum of Egyptian Antiquities, Cairo, Egypt	< 1	Male
W1013[2]	Roman	Museum of Egyptian Antiquities, Sketty, Wales	< 1	Unknown
Pediatric Mummy[3]	Ptolemaic / Roman	Michael C Carlos Museum, Georgia, USA	< 1	Unknown
ROM Mummy 210.13[4]	Roman	Royal Ontario Museum, Toronto, Canada	< 1	Unknown
Mummy Two BME[5]	Ptolemaic / Roman	The British Museum, London, UK	1 – 2	Unknown
Unknown Child[5]	Roman	The British Museum, London, UK	2	Suggested Male
EA22108[5]	Ptolemaic / Roman	The British Museum, London, UK	1.5 – 2.5	Male
EA6723[5]	Ptolemaic / Roman	The British Museum, London, UK	1.5 – 2.5	Male
EA54053[5]	Ptolemaic / Roman	The British Museum, London, UK	1.5 – 2.5	Unknown
Mummy Three AM[6]	Ptolemaic / Roman	National Museum of Antiquities, Leiden, Netherlands	1.5 – 3	Male
Qurna Child[7]	Roman	National Museum of Scotland, Edinburgh, Scotland	2 - 3	Unknown
Mummy Four[8]	Ptolemaic / Roman	Schleitheim Switzerland	2 – 3	Unknown
Penhörpabik[9]	Roman	National Museum of Scotland, Edinburgh, Scotland	3	Male
Accession # 13011[10]	Ptolemaic	Manchester Museum, Manchester, UK	3	Unknown
The Child Mummy[11]	Roman	Carnegie Museum, Pennsylvania, USA	> 3	Male
Boy Mummy[12]	New Kingdom	Torquay Museum, Torquay, UK	2 – 4	Male

KMM.A.63[13]	Roman	University of Tartu Art Museum, Tartu, Estonia	2 – 4	Male
Egyptian Child Mummy[14]	Ptolemaic / Roman	Smithsonian D.C., USA	3 – 4	Male
Mummy of a Boy (Cat. 24)[6]	Roman	National Museum of Antiquities, Leiden, Netherlands	3 – 4	Male
III 8226[15]	Ptolemaic / Roman	Museum der Kulturen, Basel, Switzerland	3 – 4	Unknown
AIA 2[8]	Ptolemaic / Roman	Australian Institute of Archaeology, Melbourne, Australia	3 – 4	Unknown
Altdorf[8]	Ptolemaic / Roman	Altdorf Secondary School, Switzerland	3.5 – 4.5	Male
Mummy of a Child (Cat.23)[6]	Ptolemaic	National Museum of Antiquities, Leiden, Netherlands	3 – 5	Unknown
Male Child[16]	Roman	The Kelsey Museum of Archaeology, Michigan, USA	4 – 5	Male
EA30364[5]	Ptolemaic / Roman	The British Museum, London, UK	4 – 5	Male
NMR26[8]	Ptolemaic / Roman	Nicholson Museum, Sydney, Australia	4 – 5	Male
Mummy of Child 1[17]	Ptolemaic / Roman	Egyptian Museum, Torino, Italy	4 – 5	Unknown
RC22[8]	Ptolemaic / Roman	Rosicrucian Museum, California, USA	4 – 5	Unknown
Nesi[18]	Ptolemaic	Victor Balaguer Library Museum, Vilanova, Spain	< 5	Unknown
Ta-Iset[19]	Ptolemaic	Musée d'histoire locale, Rueil-Malmaison France	5	Female
Tawna[20]	Ptolemaic	Penn Museum, Pennsylvania, USA	5	Suggested Female
Hawara Portrait Mummy 4[5, 21]	Roman	The British Museum, London, UK	> 5	Probable Female
Sherit[22]	Roman	Rosicrucian Egyptian Museum, California, USA	4 – 6	Female
Mummy One BM E[5]	Ptolemaic / Roman	The British Museum, London, UK	5 – 6	Female
Mummy of Child 2[17]	Roman	Egyptian Museum, Torino, Italy	> 6	Unknown
Zurich[8]	Ptolemaic / Roman	Zurich, Switzerland	5.5 – 6.5	Male
EA30363[5]	Ptolemaic / Roman	The British Museum, London, UK	6 – 7	Female

AIA 1[8]	Ptolemaic / Roman	Australian Institute of Archaeology, Melbourne, Australia	6 – 7	Unknown
Tjayasetimu[5]	Third Intermediate	The British Museum, London, UK	7	Female
Spurlock Mummy[23]	Roman	Spurlock Museum, Illinois, USA	6.5 – 8	Unknown
ANT 6942[24]	Roman	Yale Peabody Museum, Connecticut, USA	7 – 8	Unknown
Unknown[25]	Roman	Egyptian Museum of Antiquities, Cairo, Egypt	10	Unknown
Inventory MME 20[26]	New Kingdom	Medelhavsmuseet, Stockholm, Sweden	> 10	Unknown
Unknown[27]	Ptolemaic	Natural History Museum, California, USA	> 11	Male
Tjayasetimu[25]	Third Intermediate	Egyptian Museum of Antiquities, Cairo, Egypt	7 – 12	Female
Panechates[28]	Roman	The Vancouver Museum, Vancouver, Canada	7 – 12	Male
Unknown[29]	Roman	University of Sydney, Sydney, Australia	7 – 12	Male
Tutu[30]	Ptolemaic	Albert Hall Museum, Jaipur, India	> 12	Female
Minirdis[31]	Unknown	The Field Museum, Illinois, USA	12 – 14	Male
Mummy of a Boy (Cat. 29)[6]	Roman	National Museum of Antiquities, Leiden, Netherlands	9.5 – 14.5	Male
Mummy of a Boy (Cat. 30)[6]	Roman	National Museum of Antiquities, Leiden, Netherlands	14 – 14.5	Male
Mummy of a Child (Cat. 25)[6]	Roman	National Museum of Antiquities, Leiden, Netherlands	10 – 15	Unknown
KMM.A.64[13]	Roman	University of Tartu Art Museum, Tartu, Estonia	11 – 15	Male
Accession # 1768[10]	Roman	Manchester Museum, Manchester, UK	12 – 15	Male
Unknown[32]	Roman	Bernisches Historisches Museum, Bern, Switzerland	< 16	Male
Senasos[6]	Roman	National Museum of Antiquities, Leiden, Netherlands	16	Female

Mummy in Painted Shroud[33]	Roman	Louvre, Paris, France	16 – 17	Male
Annie[34]	Ptolemaic	Academy of Natural Sciences of Drexel University, Pennsylvania, USA	16 – 18	Female
Mummy A.1911.39[9]	Third Intermediate	National Museum of Scotland, Edinburgh, Scotland	< 18	Female
Mummy of the Boy[29]	Roman	University of Sydney, Sydney, Australia	> 18	Male
Mummy 31.C.1[35]	New Kingdom	University of Basel, Basel, Switzerland	> 18	Female
Mummy 31.C.3[35]	New Kingdom	University of Basel, Basel, Switzerland	> 18	Probable Male
CG 33281[25]	Roman	Museum of Egyptian Antiquities, Cairo, Egypt	17 – 19	Female
Girl Mummy 1 TL.1[36]	Roman	The Walters Art Museum, Maryland, USA	Unknown	Female
Accession # 1770[10]	Ptolemaic	Manchester Museum, Manchester, UK	Unknown	Suggested Female
Iset-Ha[37]	Ptolemaic	Rutgers Geology Museum, New Jersey, USA	Unknown	Male
Horus[29]	Roman	University of Sydney, Sydney, Australia	Unknown	Male
Accession # 9319[10]	Roman	Manchester Museum, Manchester, UK	Unknown	Suggested Male
Accession # 2109[10]	Roman	Manchester Museum, Manchester, UK	Unknown	Unknown
Accession # 1769[10]	Roman	Manchester Museum, Manchester, UK	Unknown	Unknown
Accession # 3496[10]	New Kingdom	Manchester Museum, Manchester, UK	Unknown	Unknown
Accession # 13784[10]	Middle Kingdom	Manchester Museum, Manchester, UK	Unknown	Unknown
Mummy of a Child[38]	Roman	Museum of Fine Arts, Texas, USA	Unknown	Unknown
Horemakhbit NME[26]	Ptolemaic	Medelhavsmuseet, Stockholm, Sweden	Unknown	Unknown
Eton 2309[39]	Roman	Myers Museum, Windsor, UK	Unknown	Unknown

APPENDIX B.1: REFERENCES

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APPENDIX B.2: IMPACT DIAGNOSTIC CHECKLIST

IMPACT ID: **Date of Analysis:**

Feature	Findings
Femoral Head Epiphysis	L: Indeterminate / 0 / 1 / 2 R: Indeterminate / 0 / 1 / 2
Distal Femoral Epiphysis	L: Indeterminate / 0 / 1 / 2 R: Indeterminate / 0 / 1 / 2
Distal Tibial Epiphysis	L: Indeterminate / 0 / 1 / 2 R: Indeterminate / 0 / 1 / 2
Distal Fibular Epiphysis	L: Indeterminate / 0 / 1 / 2 R: Indeterminate / 0 / 1 / 2
Humeral Head Epiphysis	L: Indeterminate / 0 / 1 / 2 R: Indeterminate / 0 / 1 / 2
Medial Clavicle Epiphysis	L: Indeterminate / 0 / 1 / 2 R: Indeterminate / 0 / 1 / 2
Hamate Hook	L: Absent Indeterminate Present R: Absent Indeterminate Present
Greater Sciatic Notch	L: 1 / 2 / 3 / 4 / 5 = R: 1 / 2 / 3 / 4 / 5 =
Subpubic Angle	> 90 Degrees / Indeterminate / < 90 Degrees
Preauricular Sulcus	L: 1 / 2 / 3 / 4 R: 1 / 2 / 3 / 4
Pubic Symphysis	Todd Phase Estimate: Suchey-Brooks Phase Estimate:
External Genitalia	Present / Indeterminate / Absent Details:

** Dental Eruption and Formation recorded on Standards Sheet Attached **

IMPACT Diagnostic Checklist

IMPACT ID: **Date of Analysis:**

Bone	**Measurement (µm → cm ÷ 10,000)**
Length of Humerus	L: R: Epiphyseal OR Diaphyseal
Length of Femur	L: R: Epiphyseal OR Diaphyseal
Length of Tibia	L: R: Epiphyseal OR Diaphyseal
Length of Fibula	L: R: Epiphyseal OR Diaphyseal
Length of Radius	L: R: Epiphyseal OR Diaphyseal
Length of Ulna	L: R: Epiphyseal OR Diaphyseal

IMPACT Diagnostic Checklist

IMPACT ID: **Date of Analysis:**

Feature	Observations
Known Provenience	
Wrappings	
Head Positioning	
Limb Positioning	Arms: Legs:
Pathology	
Hair	
Grave Goods	
Miscellaneous	

MUMMIFICATION

Cribriform Plate	In tact / Indeterminate / Broken
Excerebrated	No / Indeterminate / Yes
Resin in Cranium	No / Indeterminate / Yes
Eviscerated	No / Indeterminate / Yes

IMPACT Diagnostic Checklist

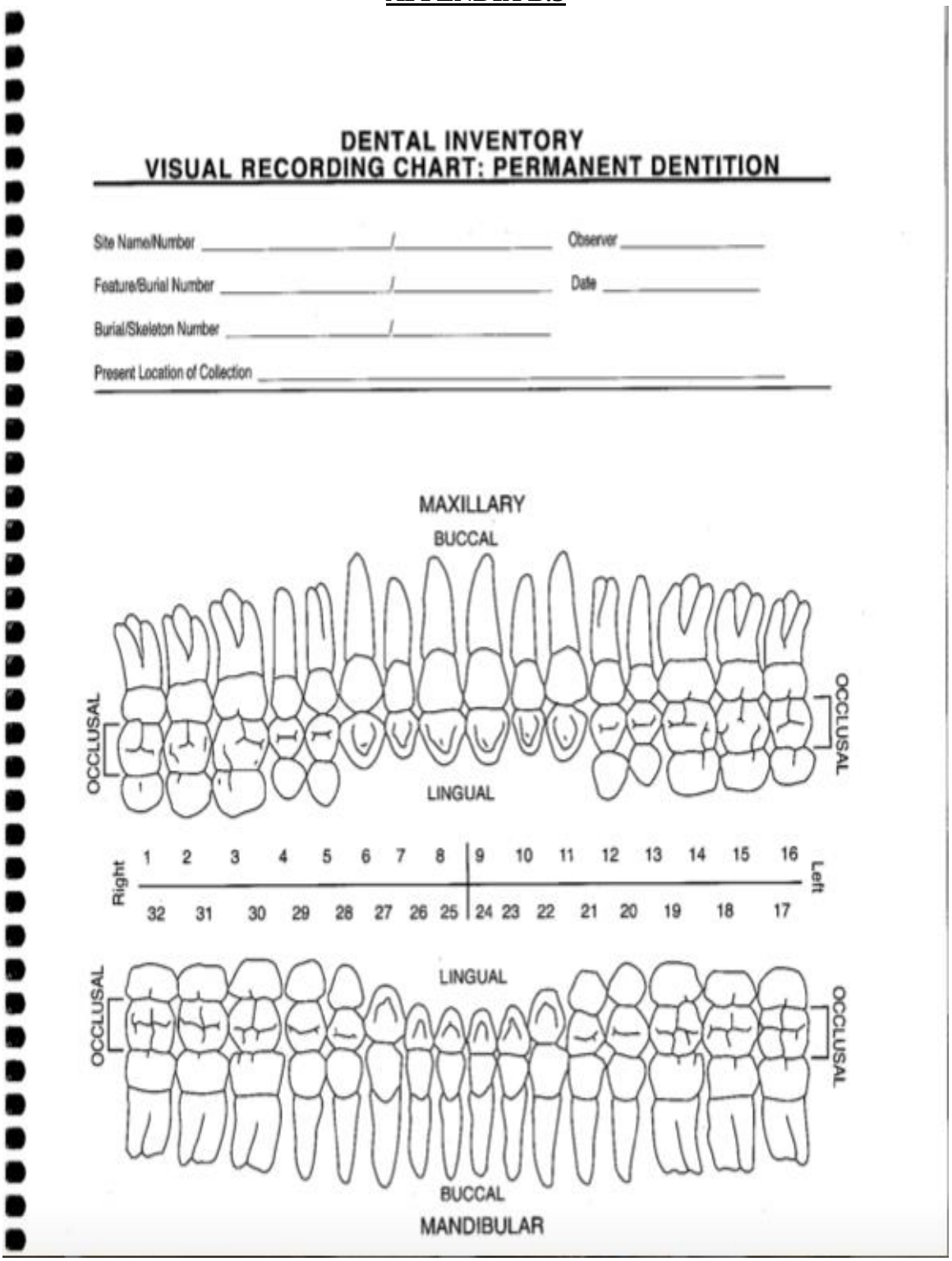
IMPACT ID: **Date of Analysis:**

CONCLUSIONS:

Sex Estimation	0 / 1 / 2 / 3 / 4 / 5 Details:
Age Estimation	Details:

OTHER OBSERVATIONS:

APPENDIX B.3



DENTAL INVENTORY
VISUAL RECORDING CHART: PERMANENT DENTITION

Site Name/Number _____/_____ Observer _____

Feature/Burial Number _____/_____ Date _____

Burial/Skeleton Number _____/_____

Present Location of Collection _____

MAXILLARY

BUCCAL

OCCLUSAL

LINGUAL

OCCLUSAL

Right 1 2 3 4 5 6 7 8 | 9 10 11 12 13 14 15 16 Left

32 31 30 29 28 27 26 25 | 24 23 22 21 20 19 18 17

OCCLUSAL

LINGUAL

OCCLUSAL

BUCCAL

MANDIBULAR

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APPENDIX B.4: RAW DATA SPREDSHEETS

IMPACT ID	Name	Radiographical Medium	Museum	Femoral Head Epiphyses	Distal Femoral Epiphyses	Distal Tibial Epiphyses	Distal Fibular Epiphyses	Humeral Head Epiphyses	Medial Clavicle Epiphyses
IMP00082	Baka / Bahka / Bahkah	CT Scan	Museum of World Treasures, Kansas, USA	Fused Bilaterally	Indeterminate	Fused Bilaterally	Fused Bilaterally	Fused Bilaterally	Partial Fusion Bilaterally
IMP00059	Unnamed	X-ray	Liverpool's World Museum, Liverpool, UK	Fused Bilaterally	Partial Fusion Bilaterally	Partial Fusion Bilaterally	Indeterminate	Partial Fusion Bilaterally	Unfused Bilaterally
IMP00031	Nesmut	First Hand	The Royal Ontario Museum, Toronto, Canada	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Unfused Bilaterally	Unfused Bilaterally
IMP00021	Fleming Mummy	CT Scan	Robert Hull Fleming Museum, Vermont, USA	Unfused Bilaterally	Indeterminate	Indeterminate	Indeterminate	Unfused Bilaterally	Unfused Bilaterally
IMP00056	Unnamed	X-ray	Art & History Museum, Brussels, Belgium	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally	Indeterminate	Unfused Bilaterally	Unfused Bilaterally
IMP00110	Keref	CT Scan	National Museum of Antiquities, Leiden, Netherlands	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally
IMP00033	Unnamed	X-ray	Art & History Museum, Brussels, Belgium	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally	Indeterminate	Unfused Bilaterally	Indeterminate
IMP00069	Nesshutefnut	X-ray	National Museum of Antiquities, Leiden, Netherlands	Indeterminate	Partial Fusion Bilaterally	Partial Fusion Bilaterally	Indeterminate	Unfused Bilaterally	Unfused Bilaterally
IMP00124	Unnamed	X-ray	Marischal Museum, Aberdeen, Scotland	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally	Indeterminate	Unfused Bilaterally	Indeterminate
IMP00115	Unnamed	CT Scan	National Museum of Antiquities, Leiden, Netherlands	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally	Indeterminate
IMP00116	Unnamed	CT Scan	National Museum of Antiquities, Leiden, Netherlands	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate
IMP00090	Mehit-em-Wesekht	X-ray	Museum of New Zealand, Te Aro, New Zealand	Partial Fusion Bilaterally	Partial Fusion Bilaterally	Partial Fusion Bilaterally	Indeterminate	Partial Fusion Bilaterally	Unfused Bilaterally
IMP00118	Unnamed	CT Scan	National Museum of Antiquities, Leiden, Netherlands	Unfused Bilaterally	Unfused Bilaterally	Indeterminate	Indeterminate	Unfused Bilaterally	Indeterminate
IMP00122	Herakleides	CT Scan	The J. Paul Getty Museum, California, USA	Fused Bilaterally	Fused Bilaterally	Partial Fusion Bilaterally	Indeterminate	Partial Fusion Bilaterally	Partial Fusion Bilaterally
IMP00117	Tasherytdjedhor / Sensaos	CT Scan	National Museum of Antiquities, Leiden, Netherlands	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally
IMP00064	Unnamed	X-ray	Liverpool's World Museum, Liverpool, UK	Indeterminate	Unfused Bilaterally	Unfused Bilaterally	Indeterminate	Unfused Bilaterally	Unfused Bilaterally
IMP00022	Little Girl from Thebes	CT Scan	Yale Peabody Museum, Connecticut, USA	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally
IMP00004	Unnamed	CT Scan	The Royal Ontario Museum, Toronto, Canada	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally
IMP00055	Unnamed	X-ray	Art & History Museum, Brussels, Belgium	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally
IMP00030	Unnamed	X-ray	Kunsthistorisches Museum, Vienna, Austria	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally	Indeterminate	Unfused Bilaterally	Unfused Bilaterally
IMP00114	Unnamed	X-ray	National Museum of Antiquities, Leiden, Netherlands	Unfused Bilaterally	Unfused Bilaterally	Unfused Bilaterally	Indeterminate	Unfused Bilaterally	Unfused Bilaterally

IMPACT ID	Name	Radiographical Medium	Museum	Dental Findings	Age Estimation
IMP00082	Baka / Bahka / Bahkah	CT Scan	Museum of World Treasures, Kansas, USA	Permanent dentition erupted except left mandibular third molar, perhaps due to agenesis.	> 18 years
IMP00059	Unnamed	X-ray	Liverpool's World Museum, Liverpool, UK	Permanent dentition present, third permanent molars partially erupted.	15 - 21 years
IMP00031	Nesmut	First Hand	The Royal Ontario Museum, Toronto, Canada	Mixed dentition, eruption of first permanent incisors/molars.	6 - 8 years
IMP00021	Fleming Mummy	CT Scan	Robert Hull Fleming Museum, Vermont, USA	Permanent dentition erupted except third molars, crown formation of left maxillary third molar present.	12 - 15 years
IMP00056	Unnamed	X-ray	Art & History Museum, Brussels, Belgium	Deciduous canines present, permanent incisors and first molars erupted, second molars show crown and root formation.	8 - 10 years
IMP00110	Keref	CT Scan	National Museum of Antiquities, Leiden, Netherlands	Deciduous dentition only, permanent first and second molar crown formation present.	3 - 6 years
IMP00033	Unnamed	X-ray	Art & History Museum, Brussels, Belgium	Mixed dentition present, eruption of maxillary and mandibular permanent first incisors and first permanent molars.	6 - 8 years
IMP00069	Nesshutefnut	X-ray	National Museum of Antiquities, Leiden, Netherlands	Dentition cannot be obsereved due to poor quality of x-ray.	14 - 18 years
IMP00124	Unnamed	X-ray	Marischal Museum, Aberdeen, Scotland	Dentition cannot be obsereved due to poor quality of x-ray.	< 10 years
IMP00115	Unnamed	CT Scan	National Museum of Antiquities, Leiden, Netherlands	Deciduous dentition only, permanent first and second molar crown formation present.	3 - 6 years
IMP00116	Unnamed	CT Scan	National Museum of Antiquities, Leiden, Netherlands	Deciduous dentition only, permanent first and second molar crown formation present.	3 - 6 years
IMP00090	Mehit-em-Wesekht	X-ray	Museum of New Zealand, Te Aro, New Zealand	Permanent dentition erupted except third molars, crown and root formation of third molars present.	14 - 18 years
IMP00118	Unnamed	CT Scan	National Museum of Antiquities, Leiden, Netherlands	Deciduous dentition only, eruption of incisors and canines, crown and root formaiton of remaining deciduous teeth.	1 - 2 years
IMP00122	Herakleides	CT Scan	The J. Paul Getty Museum, California, USA	Permanent dentition erupted in its entirety.	18 - 21 years
IMP00117	Tasherytdjedhor / Sensaos	CT Scan	National Museum of Antiquities, Leiden, Netherlands	Permanent dentition erupted except third molars, crown and root formation of third molars present.	14 - 18 years
IMP00064	Unnamed	X-ray	Liverpool's World Museum, Liverpool, UK	Deciduous dentition only, permanent first and second molar crown formation present.	3 - 6 years
IMP00022	Little Girl from Thebes	CT Scan	Yale Peabody Museum, Connecticut, USA	Deciduous dentition only, permanent first molar crown formation present.	2 - 4 years
IMP00004	Unnamed	CT Scan	The Royal Ontario Museum, Toronto, Canada	Deciduous dentition only, partial eruption of incisors bilaterally, otherwise no eruption is visible.	< 1 year
IMP00055	Unnamed	X-ray	Art & History Museum, Brussels, Belgium	Deciduous canines present, permanent incisors and first molars erupted, second molars show crown and root formation.	8 - 10 years
IMP00030	Unnamed	X-ray	Kunsthistorisches Museum, Vienna, Austria	Mixed dentition present, molars remain unerupted, however x-rays make visibility difficult due to overlapping elements.	< 10 years
IMP00114	Unnamed	X-ray	National Museum of Antiquities, Leiden, Netherlands	Skull not included in x-ray, dentition cannot be observed.	< 10 years

APPENDIX B.4: RAW DATA SPREDSHEETS

IMPACT ID	Name	Radiographical Medium	Museum	Length of Humerus (cm)	Length of Femur (cm)	Length of Tibia (cm)	Length of Fibula (cm)	Length of Radius (cm)	Length of Ulna (cm)
IMP00082	Baka / Bahka / Bahkah	CT Scan	Museum of World Treasures, Kansas, USA	L = 28.31 / R = 28.17	L = 42.72 / R = 41.72	L = 32.52 / R = 31.95	L = 32.39 / R = Indetermina	L = 18.85 / R = 18.78	L = 20.43 / R = 20.49
IMP00059	Unnamed	X-ray	Liverpool's World Museum, Liverpool, UK	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate
IMP00031	Nesmut	First Hand	The Royal Ontario Museum, Toronto, Canada	L = 20.3 / R = 20.5	L = 28.9 / R = 28.8	L = 24.3 / R = 24.4	Indeterminate	L = I / R = 23.8	L = 15.0 / R = I
IMP00021	Fleming Mummy	CT Scan	Robert Hull Fleming Museum, Vermont, USA	L = 30.82 / R = 30.86	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate
IMP00056	Unnamed	X-ray	Art & History Museum, Brussels, Belgium	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate
IMP00110	Keref	CT Scan	National Museum of Antiquities, Leiden, Netherlands	L = 12.03* / R = 12.24*	L = 17.62* / R = 17.71*	L = 13.81* / R = 13.89*	L = 14.72* / R = 14.68*	L = 10.15* / R = 9.97*	L = 10.06* / R = 9.97*
IMP00033	Unnamed	X-ray	Art & History Museum, Brussels, Belgium	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate
IMP00069	Nesshutefnut	X-ray	National Museum of Antiquities, Leiden, Netherlands	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate
IMP00124	Unnamed	X-ray	Marischal Museum, Aberdeen, Scotland	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate
IMP00115	Unnamed	CT Scan	National Museum of Antiquities, Leiden, Netherlands	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate
IMP00116	Unnamed	CT Scan	National Museum of Antiquities, Leiden, Netherlands	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate
IMP00090	Mehit-em-Wesekht	X-ray	Museum of New Zealand, Te Aro, New Zealand	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate
IMP00118	Unnamed	CT Scan	National Museum of Antiquities, Leiden, Netherlands	Indeterminate	L = 11.93* / R = 12.12*	Indeterminate	Indeterminate	Indeterminate	Indeterminate
IMP00122	Herakleides	CT Scan	The J. Paul Getty Museum, California, USA	L = 30.47 / R = 30.59	L = 45.97 / R = 46.03	L = 35.96 / R = 36.41	L = 35.10 / R = 35.24	L = 24.06 / R = 24.10	L = 23.82 / R = 23.85
IMP00117	Tasherytdjedhor / Sensaos	CT Scan	National Museum of Antiquities, Leiden, Netherlands	Indeterminate	Indeterminate	L = 28.02* / R = 28.13*	L = 27.25* / R = 27.47*	L = 16.89* / R = 16.96*	L = 17.17* / R = 17.28*
IMP00064	Unnamed	X-ray	Liverpool's World Museum, Liverpool, UK	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate
IMP00022	Little Girl from Thebes	CT Scan	Yale Peabody Museum, Connecticut, USA	L = 11.1 / R = 10.9	L = 13.5 / R = 13.7	L = 117.8 / R = 118.2	Indeterminate	Indeterminate	Indeterminate
IMP00004	Unnamed	CT Scan	The Royal Ontario Museum, Toronto, Canada	L = 6.79* / R = 6.89*	L = 8.51* / R = 8.52*	L = 6.70* / R = 6.71*	L = 6.49* / R = 6.56*	L = 4.57* / R = 4.60*	L = 4.55* / R = 4.59*
IMP00055	Unnamed	X-ray	Art & History Museum, Brussels, Belgium	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate
IMP00030	Unnamed	X-ray	Kunsthistorisches Museum, Vienna, Austria	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate
IMP00114	Unnamed	X-ray	National Museum of Antiquities, Leiden, Netherlands	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate

IMPACT ID	Name	Radiographical Medium	Museum	Greater Sciatic Notch Scor	Subpubic Angle	Preauricular Sulcus Scorir	Pubic Symphysis Scoring	External Genitalia	Sex Estimation
IMP00082	Baka / Bahka / Bahkah	CT Scan	Museum of World Treasures, Kansas, USA	1 / Female	> 90°	2 / Wide, shallow	Todd Phase = 2 / Suchey-Br	Absent	Female
IMP00059	Unnamed	X-ray	Liverpool's World Museum, Liverpool, UK	5 / Female	> 90°	Indeterminate	Indeterminate	Absent	Female
IMP00031	Nesmut	First Hand	The Royal Ontario Museum, Toronto, Canada	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Present / Female	Female
IMP00021	Fleming Mummy	CT Scan	Robert Hull Fleming Museum, Vermont, USA	2 / Probable Female	> 90°	2 / Wide, shallow	Todd Phase = 1 / Suchey-Br	Absent	Probable Female
IMP00056	Unnamed	X-ray	Art & History Museum, Brussels, Belgium	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Present / Male	Male
IMP00110	Keref	CT Scan	National Museum of Antiquities, Leiden, Netherlands	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Absent	Indeterminate (Suggested Male)
IMP00033	Unnamed	X-ray	Art & History Museum, Brussels, Belgium	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Absent	Indeterminate
IMP00069	Nesshutefnut	X-ray	National Museum of Antiquities, Leiden, Netherlands	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Absent	Indeterminate (Suggested Male)
IMP00124	Unnamed	X-ray	Marischal Museum, Aberdeen, Scotland	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Absent	indeterminate (suggested Female)
IMP00115	Unnamed	CT Scan	National Museum of Antiquities, Leiden, Netherlands	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Absent	Indeterminate
IMP00116	Unnamed	CT Scan	National Museum of Antiquities, Leiden, Netherlands	3 / Indeterminate	Indeterminate	Indeterminate	Indeterminate	Present / Male	Male
IMP00090	Mehit-em-Wesekht	X-ray	Museum of New Zealand, Te Aro, New Zealand	4 / Probable Male	> 90°	Indeterminate	Indeterminate	Absent	Female
IMP00118	Unnamed	CT Scan	National Museum of Antiquities, Leiden, Netherlands	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Present / Male	Male
IMP00122	Herakleides	CT Scan	The J. Paul Getty Museum, California, USA	4 / Probable Male	< 90°	3 / Well defined, narrow	Todd Phase = 2 / Suchey-Br	Absent	Probable Male
IMP00117	Tasherytdjedhor / Sensaos	CT Scan	National Museum of Antiquities, Leiden, Netherlands	2 / Probable Female	> 90°	Indeterminate	Todd Phase = 1 / Suchey-Br	Absent	Probable Female
IMP00064	Unnamed	X-ray	Liverpool's World Museum, Liverpool, UK	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Absent	Indeterminate (Suggested Male)
IMP00022	Little Girl from Thebes	CT Scan	Yale Peabody Museum, Connecticut, USA	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Present / Female	Female
IMP00004	Unnamed	CT Scan	The Royal Ontario Museum, Toronto, Canada	3 / Indeterminate	< 90°	3 / Well defined, narrow	Todd Phase = 1 / Suchey-Br	Present / Male	Male
IMP00055	Unnamed	X-ray	Art & History Museum, Brussels, Belgium	3 / Indeterminate	< 90°	Indeterminate	Indeterminate	Present / Male	Male
IMP00030	Unnamed	X-ray	Kunsthistorisches Museum, Vienna, Austria	3 / Indeterminate	> 90°	Indeterminate	Indeterminate	Present / Female	Female
IMP00114	Unnamed	X-ray	National Museum of Antiquities, Leiden, Netherlands	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Absent	Indeterminate

APPENDIX B.4: RAW DATA SPREDSHEETS

IMPACT ID	Name	Radiographical Medium	Museum	Cribiform Plate State	Excerebration	Resin Presence in Craniur	Evisceration	Age Estimation
IMP00082	Baka / Bahka / Bahkah	CT Scan	Museum of World Treasures, Kansas, USA	Indeterminate	No	Absent	Yes	> 18 years
IMP00059	Unnamed	X-ray	Liverpool's World Museum, Liverpool, UK	Indeterminate	Indeterminate	Indeterminate	Yes	15 - 21 years
IMP00031	Nesmut	First Hand	The Royal Ontario Museum, Toronto, Canada	Unbroken	No	No	Indeterminate	6 - 8 years
IMP00021	Fleming Mummy	CT Scan	Robert Hull Fleming Museum, Vermont, USA	Broken	Yes	Absent	Indeterminate	12 - 15 years
IMP00056	Unnamed	X-ray	Art & History Museum, Brussels, Belgium	Indeterminate	Indeterminate	Absent	Indeterminate	8 - 10 years
IMP00110	Keref	CT Scan	National Museum of Antiquities, Leiden, Netherlands	Broken	Yes	Absent	Indeterminate	3 - 6 years
IMP00033	Unnamed	X-ray	Art & History Museum, Brussels, Belgium	Indeterminate	Indeterminate	Absent	Indeterminate	6 - 8 years
IMP00069	Nesshutefnut	X-ray	National Museum of Antiquities, Leiden, Netherlands	Indeterminate	Indeterminate	Indeterminate	Indeterminate	14 - 18 years
IMP00124	Unnamed	X-ray	Marischal Museum, Aberdeen, Scotland	Indeterminate	Yes	Yes	Yes	< 10 years
IMP00115	Unnamed	CT Scan	National Museum of Antiquities, Leiden, Netherlands	Indeterminate	Yes	Absent	Indeterminate	3 - 6 years
IMP00116	Unnamed	CT Scan	National Museum of Antiquities, Leiden, Netherlands	Indeterminate	Yes	Absent	No	3 - 6 years
IMP00090	Mehit-em-Wesekht	X-ray	Museum of New Zealand, Te Aro, New Zealand	Broken	Yes	Absent	Indeterminate	14 - 18 years
IMP00118	Unnamed	CT Scan	National Museum of Antiquities, Leiden, Netherlands	Broken	Yes	Absent	Yes	1 - 2 years
IMP00122	Herakleides	CT Scan	The J. Paul Getty Museum, California, USA	In tact	No	Absent	Yes	18 - 21 years
IMP00117	Tasherytdjedhor / Sensaos	CT Scan	National Museum of Antiquities, Leiden, Netherlands	Broken	Yes	Absent	Yes	14 - 18 years
IMP00064	Unnamed	X-ray	Liverpool's World Museum, Liverpool, UK	Indeterminate	Indeterminate	Indeterminate	Indeterminate	3 - 6 years
IMP00022	Little Girl from Thebes	CT Scan	Yale Peabody Museum, Connecticut, USA	Indeterminate	Indeterminate	Absent	Yes	2 - 4 years
IMP00004	Unnamed	CT Scan	The Royal Ontario Museum, Toronto, Canada	Indeterminate	Indeterminate	Absent	No	< 1 year
IMP00055	Unnamed	X-ray	Art & History Museum, Brussels, Belgium	Indeterminate	Indeterminate	Indeterminate	Indeterminate	8 - 10 years
IMP00030	Unnamed	X-ray	Kunsthistorisches Museum, Vienna, Austria	Indeterminate	Indeterminate	Absent	Indeterminate	< 10 years
IMP00114	Unnamed	X-ray	National Museum of Antiquities, Leiden, Netherlands	Indeterminate	Indeterminate	Indeterminate	Indeterminate	< 10 years

IMPACT ID	Name	Radiographical Medium	Museum	Pathological Findings	Hair	Grave Goods
IMP00082	Baka / Bahka / Bahkah	CT Scan	Museum of World Treasures, Kansas, USA	None	Long red tinted tufts scattered around the top of the skull, articulated by remaining scalp.	None
IMP00059	Unnamed	X-ray	Liverpool's World Museum, Liverpool, UK	None	Short tufts of hair articulated by remaining scalp present.	None
IMP00031	Nesmut	First Hand	The Royal Ontario Museum, Toronto, Canada	Detailed in Appendix	None	None
IMP00021	Fleming Mummy	CT Scan	Robert Hull Fleming Museum, Vermont, USA	None	None	None
IMP00056	Unnamed	X-ray	Art & History Museum, Brussels, Belgium	None	None	None
IMP00110	Keref	CT Scan	National Museum of Antiquities, Leiden, Netherlands	None	None	None
IMP00033	Unnamed	X-ray	Art & History Museum, Brussels, Belgium	None	None	None
IMP00069	Nesshutefnut	X-ray	National Museum of Antiquities, Leiden, Netherlands	None	None	Ring present on the third or fourth fingers.
IMP00124	Unnamed	X-ray	Marischal Museum, Aberdeen, Scotland	None	None	Papyrus scroll placed within thoracic cavity.
IMP00115	Unnamed	CT Scan	National Museum of Antiquities, Leiden, Netherlands	10 cm x 3 cm hole at right s	None	None
IMP00116	Unnamed	CT Scan	National Museum of Antiquities, Leiden, Netherlands	None	None	None
IMP00090	Mehit-em-Wesekht	X-ray	Museum of New Zealand, Te Aro, New Zealand	None	None	None
IMP00118	Unnamed	CT Scan	National Museum of Antiquities, Leiden, Netherlands	None	None	None
IMP00122	Herakleides	CT Scan	The J. Paul Getty Museum, California, USA	None	Short tufts of dark hair articulated by remaining scalp present.	None
IMP00117	Tasherytdjedhor / Sensaos	CT Scan	National Museum of Antiquities, Leiden, Netherlands	None	Short tufts of hair articulated by remaining scalp present.	None
IMP00064	Unnamed	X-ray	Liverpool's World Museum, Liverpool, UK	None	None	Amulet in mouth and around genital area.
IMP00022	Little Girl from Thebes	CT Scan	Yale Peabody Museum, Connecticut, USA	None	None	None
IMP00004	Unnamed	CT Scan	The Royal Ontario Museum, Toronto, Canada	None	None	None
IMP00055	Unnamed	X-ray	Art & History Museum, Brussels, Belgium	None	None	None
IMP00030	Unnamed	X-ray	Kunsthistorisches Museum, Vienna, Austria	None	None	None
IMP00114	Unnamed	X-ray	National Museum of Antiquities, Leiden, Netherlands	None	None	None